Lake Superior Mining Institute

PROCEEDINGS-1911

Lake Superior Mining

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Baltic Mine, Pickands, Mather & Co., Miners' Club House, Palatka, Mich.

Special Trains and Automobiles at Vulcan, Mich.

Peninsular Power and Development Co. Constructing Dam at Twin Falls near Iron Mountain, Mich.

Brier Hill Mine, Penn Iron Mining Co., Vulcan, Mich. Steel Head Frame, Trestles and Circular Ore Pockets.

PROCEEDINGS

OF THE

LAKE SUPERIOR MINING INSTITUTE

SIXTEENTH ANNUAL MEETING

MENOMINEE RANGE, MICHIGAN

AUGUST 22, 23, 24, 1911

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M'DONALD, D. B..................................Virginia, Minn.
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M'DOWELL, JOHN ....Hibbing, Minn.
M'GEE; M. B...................................Crystal Falls, Mich.
M'GONAGLE, WILLIAM A...............Wolvin Bldg., Duluth, Minn.
M'GREGOR, SILAS J........................Iron Mountain, Mich.
M'CORMICK, EDWARD ....Hibbing, Minn.
M'CORKINDALE, W. J...........................Ishpeming, Mich.
M'INDOE, JAMES A................................Norway, Mich.
M'KEEVER, R. T.................82 Devonshire St., Boston, Mass.
M'KEE, WILL E.....................................Warren, Ariz.
M'LAUGHLIN, W. J.................................Loretto, Mich.
M'LEAN, JOHN H....................................Duluth, Minn.

M'LEAN, RICHARD EARLE.................Wells, Delta Co., Mich.
M'NAMARA, THOMAS B..........................Ironwood, Mich.
M'NAMARA, TIMOTHY ....Fierro, New Mexico
M'NAIR, F. W....................................Houghton, Mich.
M'NEIL, E. D......................................Virginia, Minn.

NELSON, S. T.......................1170 W. Lake St., Chicago, Ills.
NEWETT, GEORGE A............................Ishpeming, Mich.
NEWTON, L. L....................1324 La Salle Ave., Chicago, Ills.
NEWBY, WILLIAM ....Ironwood, Mich.
NICHOLAS, THOMAS J.............................Aurora, Minn.
NICHOLS, F. W....................................Houghton, Mich.
NIXON, JOHN A.................................Ishpeming, Mich.
NOBLE, THOMAS H.............................Marquette, Mich.

OLCOTT, WILLIAM J...............................Duluth, Minn.
ORBISON, THOMAS W.............................Appleton, Wis.
ORR, FRANK D......................Exchange Bldg., Duluth, Minn.
OSBORN, CHASE S.........................Sault Ste. Marie, Mich.

PALMER, E. V......................308 McPhee Bldg., Denver, Colo.
PARKER, RICHARD A..............929 Foster Bldg., Denver, Colo.
PASCOE, PETER W................................Republic, Mich.
PASCOE, WILLIAM ....Hibbing, Minn.
PATRICK, RICHARD S.........314-15 Sellwood Block, Duluth, Minn.
PENTECOST, JOHN ....Calumet, Mich.
PENTON, JOHN A..............Iron Trade Review, Cleveland, Ohio
PENGILLY, EDWARD ....Crystal Falls, Mich.
PERKINS, SAMUEL J............................Ironwood, Mich.
PETERSON, JOHN O.............921 Railroad Ave., Hancock, Mich.
PHILLIPS, W. G...................................Calumet, Mich.
PIPER, JAMES ....Miami, Arizona
PITKIN, S. H......................682 W. Market St., Akron, Ohio
PLATTO, FRANK ....Ishpeming, Mich.
POLLOCK, CHARLES S.........................Minneapolis, Minn.
POPE, GRAHAM ....Houghton, Mich.
POWELL, D. W...................................Marquette, Mich.
PRESCOTT, FRED M.................Oregon St., Milwaukee, Wis.
PRESCOTT, L. L................................Menominee, Mich.
PRESHO, EDWARD W.............................Houghton, Mich.
PRYOR, R. C.......................................Houghton, Mich.

QUIGLEY, G. J.......................................Antigo, Wis.
QUINE, JOHN THOMAS.............413 Vine St., Ishpeming, Mich.
QUINN, CLEMENT KRUSE.........................Virginia, Minn.

RAHT, CHARLES......................29 Broadway, New York City

RAISKY, F. H.......................................Ishpeming, Mich.
RALEY, ROBERT J..................Spalding Hotel, Duluth, Minn.
RASHLEIGH, WILLIAM J............................Aurora, Minn.
RATTLE, W. J.................33 Commercial Bldg., Cleveland, Ohio
REDFERN, JOHN A.................................Hibbing, Minn.
REEDER, J. T.....................................Houghton, Mich.
REEDER, EDWIN C..................1917 Fisher Bldg., Chicago, Ills.
REEDER, J. H.....................................Calumet, Mich.
REIGART, JOHN R................................Princeton, Mich.
REYNOLDS, M. K..................430 E. Arch St., Marquette, Mich.
RICHARDS, WILLIAM J......................Crystal Falls, Mich.
RICHARDS, MORRIS EARL..........................Virginia, Minn.
RICHARDS, WILLIAM J.........................Painesdale, Mich.
RICHEY, E. W...........211 Railway Exchange Bldg., Chicago, Ills.
RIDLEY, FREDERICK WILLIAM...................Calumet, Mich.
ROBERTS, HARRY ....Duluth, Minn.
ROBERTS, RICHARD ....Negaunee, Mich.
ROBERTS, ALTON T............................Marquette, Mich.
ROBERTSON HUGH J.............................Escanaba, Mich.
ROBINSON, JAMES A.............................Hibbing, Minn.
ROHN, OSCAR ....Butte, Mont.
ROOD, DANA C....................................Hibbing, Minn.
ROSE, R. S.......................................Marquette, Mich.
ROSKILLY, JOSEPH ....Virginia, Minn.
ROUGH, JAMES H.................................Negaunee, Mich.
ROWE, HENRY ....Ironwood, Mich.
ROWE, WM. C....................................Bessemer, Mich.
RUEZ, GEORGE F................................Ishpeming, Mich.
RUMSEY, SPENCER S..............610 Wolvin Bldg., Duluth, Minn.
RUNDLE, A. J.............................Iron Mountain, Mich.
RUSSELL, C. W.......................R. W. & F Co., Detroit, Mich.
RYAN, JOHN A...............................Iron Mountain, Mich.

SALOMONSON, H....................................Norway, Mich.
SALSICH, L. R...................................Coleraine, Minn.
SALVICK, WILLIAM V...........................Houghton, Mich.
SAVAGE, J. A.....................................Hibbing, Minn.
SCADDEN, FRANK.............................Crystal Falls, Mich.
SCHLESINGER, H. J............................Milwaukee, Wis.
SCHUBERT, GEORGE P..........................Hancock, Mich.
SCHULZE, W. J....................................Virginia, Minn.
SCOTT, D. D.....................535 W. Paul St., Rochester, N. Y.
SEAMAN, A. E...................................Houghton, Mich.
SEBENIUS, JOHN UNO.................Wolvin Bld., Duluth, Minn.
SEELYE, R. W.............................Sault Ste. Marie, Ont.
SELLS, MAX ....Florence, Wis.
SENTER, A. W.....................................Hubbell, Mich.

SEPARK, E. A. . . . . Wolvin Bldg., Duluth, Minn.
SHEA, J. D. . . . . Bessemer, Mich.
SHERLOCK, THOMAS . . . . Escanaba, Mich.
SHERRERD, JOHN M. . . . . 340 Spring Garden St., Easton, Pa.
SHIELDS, IRVIN J. . . . . Houghton, Mich.
SIEBENTHAL, W. A. . . . . Republic, Mich.
SILL, GEO. A. . . . . 504 Marquette Bldg., Chicago, Ills.
SIMMONS, CHARLES . . . . Beacon, Mich.
SJOGREN, PROF. H. . . . . Nynashamn, Sweden
SKINNER, MORTIMER B. 558-560 W. Washington Blvd., Chicago, Ills.
SLAUGHTER, WILLIAM F. . . . . Vulcan, Mich.
SLINEY, DAVID J. . . . . Ishpeming, Mich.
SMITH, FRED . . . . Kearsarge, Mich.
SMITH, GEORGE M. . . . . Duluth, Minn.
SMITH, WILLARD J. . . . . Mohawk, Mich.
SMITH, CARL G. . . . . Montreal, Wis.
SMITH, ALFRED L. . . . . Wakefield, Mich.
SMYTH, H. L. . . . . Rotch Bldg., Cambridge, Mass.
SOADY, HARRY . . . . Duluth, Minn.
SORNBERGER, E. C. . . . . 208 Lancaster Ave., Buffalo, N. Y.
SPERR, F. W. . . . . Houghton, Mich.
SPORLEY, CHARLES L. . . . . Negaunee, Mich.
STAKEL, CHARLES J. . . . . Ishpeming, Mich.
STANTON, F. McM. . . . . 208 5th Ave., New York City
STANTON, J. R. . . . . 11 William St., New York City
STEPHENS, JAMES . . . . Ishpeming, Mich.
STEVENS, THOMAS J. . . . . Ironwood, Mich.
STEVENS, HORACE J. . . . . Houghton, Mich.
STOEK, H. H. University of Illinois, Urbana, Ills.
SUESS, JOSEPH E. . . . . Negaunee, Mich.
SULLIVAN, F. J. . . . . Ironwood, Mich.
SUTHERLAND, D. E. . . . . Ironwood, Mich.
SWAIN, RICHARD A. . . . . General Electric Co., Minneapolis, Minn.
SWEENEY, E. F. . . . . Baxter Springs, Kan.
SWIFT, GEORGE D. . . . . Duluth, Minn.
SWIFT, H. LEIGH . . . . Houghton, Mich.
SWIFT, PAUL D. . . . . Houghton, Mich.

TANCIG, A. . . . . Hibbing, Minn.
TARR, S. W. . . . . 610 Wolvin Bldg., Duluth, Minn.
TAYLOR, JAMES HALL . . . . Box 485, Chicago, Ills.
THIEMAN, EDWARD . . . . Florence, Wis.
THOMAS, WILLIAM . . . . Ironwood, Mich.
THOMAS, KIRBY . . . . 505 Pearl St., New York City
THOMS, REUBEN KNIGHT . . . . Ely, Minn.
THOMPSON, G. H. . . . . Hibbing, Minn.
THOMPSON, HENRY S. . . . . Beacon, Mich.

THOMPSON, A. W....................................Vulcan, Mich.
THOMPSON, JAMES R............................Ishpeming, Mich.
TILLINGHAST, EDWARD S........................Hibbing, Minn.
TOBIN, JAMES ....Florence, Wis.
TOWNSEND, C. V R...............................Negaunee, Mich.
TRAVER, WILBER H....................Fisher Bldg., Chicago, Ills.
TREBILCOCK, JOHN ....Ishpeming, Mich.
TREBILCOCK, WILLIAM ....North Freedom, Wis.
TREPANIER, HENRY ....Iron Mountain, Mich.
TREZONA, CHARLES ....Ely, Minn.
TREVARROW, HENRY ....Negaunee, Mich.
TREVARTHAN, W. J...............................Bessemer, Mich.
TREVIRANUS, GEORGE.....Care D. M. & N. Docks, Duluth, Minn.
TRIPP, CHESTER D.......1515 Corn Exchange Bldg., Chicago, Ills.
TRUETTNER, IRVING W.........................Bessemer, Mich.
TRUDGEON, JOHN ....Wakefield, Mich.
TUFTS, JOHN W.................900 Hackett Ave., Milwaukee, Wis.
TURNER, CHAS. N.............Colby-Abbott Bldg., Milwaukee, Wis.
TYLER, CHARLES ....Negaunee, Mich.

UREN, WILLIAM J.................................Calumet, Mich.
UHLER, FRED WALTER ....Buhl, Minn.

VALLATT, BENJ. W...............................Ironwood, Mich.
VAN DYKE, W. D.................................Milwaukee, Wis.
VANDEVENTER, VIVIAN H......................Ishpeming, Mich.
VAN EVERA, JOHN R............................Marquette, Mich.
VAN EVERA, WILBUR.............................Virginia, Minn.
VAN MATER, J. A.....................55 Wall St., New York City
VAN ORDEN, F. L...............................Houghton, Mich.
VAN VALKENBURG, ALLEN J...................Abbottsford, Wis.
VILAS, P. M...........425 New York Life Bldg., Minneapolis, Minn.
VILAS, ROYAL L...............................Ishpeming, Mich.
VIVIAN, JAMES G.................909 Alworth Bldg., Duluth, Minn.
VIVIAN, DAVID L.......................................Gay, Mich.
VOGEL, F. A..........................25 Broad St., New York City

WADE, JEPTHA H...................Wade Bldg., Cleveland, Ohio
WAGNER, JOHN M................................Houghton, Mich.
WALL, JAMES S..................................Iron River, Mich.
WALLACE, GEORGE ....Marquette, Mich.
WALKER, ROBERT L.................................Diorite, Mich.
WARE, JOHN FRANKLIN................128 Park St., Dayton, Ohio
WARE, FRED ....Negaunee, Mich.
WARREN, O. B.......................................Hibbing, Minn.
WARNE, EDW. S.................................Point Mills, Mich.
WARRINER, S. D...............................Wilkesbarre, Pa.

WATSON, CHARLES H........................Crystal Falls, Mich.
WEARNE, WILLIAM ....Hibbing, Minn.
WEBB, FRANCES J..............519 Providence Bldg., Duluth, Minn.
WEED, LOUIS B.............................Sunrise, Wyoming.
WELLS, PEARSON ....Ironwood, Mich.
WELKER, W. F...................................Ashland, Wis.
WENGLER, MATT P.........1055 Cambridge Ave., Milwaukee, Wis.
WESSINGER, W. E..................610 Wolvin Bldg., Duluth, Minn.
WESSINGER, HENRY J.............610 Wolvin Bldg., Duluth, Minn.
WEST, WILLIAM J.................................Hibbing, Minn.
WHEELWRIGHT, O. W.............................Florence, Wis.
WHITE, WILLIAM ....Virginia, Minn.
WHITE, EDWIN E..............................Ishpeming, Mich.
WHITEHEAD, R. G..................................Amasa, Mich.
WHITESIDE, DR. JOHN W.........................Ironwood, Mich.
WILLEY, NORMAN W........Shenango Furnace Co., Hibbing, Minn.
WILKINS, WILLIAM ....Ashland, Wis.
WILLIAMS, THOMAS H...............................Ely, Minn.
WILLIAMS, HERBERT H.........................Marquette, Mich.
WILLIAMS, PERCIVAL S..........................Ramsay, Mich.
WILSON, EUGENE B...............................Scranton, Pa.
WINCHELL, HORACE V........505 Palace Bldg., Minneapolis, Minn.
WINTER, JOSEPH H.............................Negaunee, Mich.
WITHERBEE, F. S..........................Port Henry, New York
WOODBRIDGE, DWIGHT E..........................Duluth, Minn.
WOODWORTH, G. L.............................Iron River, Mich.
WOODWORTH, R. B.............427 Carnegie Bldg., Pittsburg, Pa.
WORDEN, EUCLID P.............................Milwaukee, Wis.

YATES, WILLIAM H.............................Negaunee, Mich.
YOUNG, H. OLIN ....Ishpeming, Mich.
YOUNGS, FRANK W.............................Iron River, Mich.
YOUNGS, G. W.................................Iron River, Mich.
YUNGBLUTH, A. J.............................Ishpeming, Mich.

ZAPFFE, ...213 Citizens State Bank Bldg., Brainerd, Minn.

DECEASED MEMBERS.

ARMSTRONG, J. F.	March 3rd, 1898
BAWDEN, JOHN T.	1899
BENNETT, JAMES H.	
BIRKHEAD, LENNOX	April, 1911
BROOKS, T. B.	1902
BULLOCK, M. C.	January 12th, 1899
COWLING, NICHOLAS	1910
CONRO, ALBERT	January 10th, 1901
CLEAVES, WILL S.	1910
CHADBOURNE, T. L.	April 18, 1911
CUMMINGS, GEO P.	March 14, 1911
DANIELS, JOHN	September 13th, 1898
DICKENSON, W. E.	June 15th, 1899
DOWNING, W. H.	October, 1906
DUNOAN, JOHN	June, 1904
DUNSTON, THOMAS B.	
GARBERSON, WILLIAM R.	April 29th, 1908
HALL, CHAS. H.	February, 1910
HARPER, GEORGE VANCE	March, 1905
HASELTON, H. S.	July 27th, 1911
HAYDEN, GEORGE	July 27th, 1902
HINTON, FRANCIS	1896
HOLLAND, JAMES	September 3rd, 1900
HOLLEY, S. H.	July 4th, 1899
HOUGHTON, JACOB	December 30th, 1903
HYDE, WELCOME	
JEFFERY, WALTER M.	May 26th, 1906
JOCHIM, JOHN W.	January 17th, 1905
KRUSE, JOHN C.	October 28th, 1907
LUSTFIELD, A.	May 26th, 1904
LYON, JOHN B.	February 13th, 1900
MARR, GEORGE A.	March, 1905
MITCHELL, SAMUEL	May 10th, 1908
M'VICHIE, D.	September 14th, 1906
NINESE, EDMUND	January 3rd, 1909
OLIVER, HENRY W.	February 8th, 1904
PEARCE, H. A.	1905
PERSONS, GEORGE R.	March 26th, 1908
ROBERTS, E. S.	
ROWE, JAMES	March 26th, 1911
RYAN, EDWARD	1901
SHEPHARD, AMOS	June 6th, 1905
STANLAKE, JAMES	September 23rd, 1910
STANTON, JOHN	February 23rd, 1906
STURTEVANT, H. B.	November 22nd, 1910
THOMAS, HENRY	December, 1905
TREVARTHEN, G. C.	January, 1898
TRUSCOTT, HENRY	May 7th, 1910
VAN DYKE, JOHN H.	1906
WALLACE, JOHN	1898
WHITE, PETER	June 6th, 1908
WHITNEY, J. D.	1894
WILLIAMS, W. H.	1897

LIST OF PAPERS PUBLISHED IN PRECEDING VOLUMES.

1901.

1902.

1903.

RULES OF THE INSTITUTE.

I.

OBJECTS.

The objects of the Lake Superior Mining Institute are to promote the arts and sciences connected with the economical production of the useful minerals and metals in the Lake Superior region, and the welfare of those employed in these industries, by means of meetings of social intercourse, by excursions, and by the reading and discussion of practical and professional papers, and to circulate, by means of publications among its members the information thus obtained.

II.

MEMBERSHIP.

Any person interested in the objects of the Institute is eligible for membership.

Honorary members not exceeding ten in number, may be admitted to all the privileges of regular members except to vote. They must be persons eminent in mining or sciences relating thereto.

III.

ELECTION OF MEMBERS.

Each person desirous of becoming a member shall be proposed by at least three members approved by the Council, and elected by ballot at a regular meeting (or by ballot at any time conducted through the mail, as the Council may prescribe), upon receiving three-fourths of the votes cast. Application must be accompanied by fee and dues as provided by Section V.

Each person proposed as an honorary member shall be recommended by at least ten members, approved by the Council, and elected by ballot at a regular meeting, (or by ballot at any time conducted through the mail, as the Council may prescribe), on receiving nine-tenths of the votes cast.

IV.

WITHDRAWAL FROM MEMBERSHIP.

Upon the recommendation of the Council, any member may be stricken from the list and denied the privilege of membership, by the vote of three-fourths of the members present at any regular meeting, due notice having been mailed in writing by the Secretary to him.

V.

DUES.

The membership fee shall be five dollars and the annual dues five dollars, and applications for membership must be accompanied by a remittance of ten dollars; five dollars for such membership fee and five dollars for dues for the first year. Honorary members shall not be liable to dues. Any member not in arrears may become a life member by the payment of fifty dollars at one time, and shall not be liable thereafter to annual dues. Any member in arrears may, at the discretion of the Council, be deprived of the receipt of publications or be stricken from the list of members when in arrears six months; Provided, That he may be restored to membership by the Council on the payment of all arrears, or by re-election after an interval of three years.

VI.

OFFICERS.

There shall be a President, five Vice Presidents, five Managers, a Secretary and a Treasurer, and these Officers shall constitute the Council.

VII.

TERM OF OFFICE.

The President, Secretary and Treasurer shall be elected for one year, and the Vice Presidents and Managers for two years, except that at the first election two Vice Presidents and three Managers shall be elected for only one year. No President, Vice President, or Manager shall be eligible for immediate re-election to the same office at the expiration of the term for which he was elected. The term of office shall continue until the adjournment of the meeting at which their successors are elected.

Vacancies in the Council, whether by death, resignation, or the failure for one year to attend the Council meetings, or to perform the duties of the office, shall be filled by the appointment of the Council, and any person so appointed shall hold office for the remainder of the term for which his predecessor was elected or appointed; Provided, That such appointment shall not render him ineligible at the next election.

VII.

DUTIES OF OFFICERS.

All the affairs of the Institute shall be managed by the Council except the selection of the place of holding regular meetings.

The duties of all Officers shall be such as usually pertain to their offices, or may be delegated to them by the Council.

The Council may in its discretion require bonds to be given by the Treasurer, and may allow the Secretary such compensation for his services as they deem proper.

At each annual meeting the Council shall make a report of proceedings to the Institute, together with a financial statement.

Five members of the Council shall constitute a quorum; but the Council may appoint an executive committee, business may be transacted at a regularly called meeting of the Council, at which less than a quorum is present, subject to the approval of a majority of the Council, subsequently given in writing to the Secretary and recorded by him with the minutes.

There shall be a meeting of the Council at every regular meeting of the Institute and at such other times as they determine.

IX.

ELECTION OF OFFICERS.

Any five members not in arrears, may nominate and present to the Secretary over their signatures, at least thirty days before the annual meeting, the names of such candidates as they may select for offices falling under the rules. The Council, or a committee thereof duly authorized for the purpose, may also make similar nominations. The assent of the nominees shall have been secured in all cases.

No less than two weeks prior to the annual meeting, the Secretary shall mail to all members not in arrears a list of all nominations made and the number of officers to be voted for in the form of a letter ballot. Each member may vote either by striking from or adding to the names upon the list, leaving names not exceeding in number the officers to be elected, or by preparing a new list, signing the ballot with his name, and either mailng it to the Secretary, or presenting it in person at the annual meeting.

In case nominations are not made thirty days prior to the date of the annual meeting for all the offices becoming vacant under the rules, nominations for such offices may be made at the said meeting by five members, not in arrears, and an election held by a written or printed ballot.

The ballots in either case shall be received and examined by three tellers appointed at the annual meeting by the presiding officer; and the persons who shall have received the greatest number of votes for the several offices shall be declared elected. The ballot shall be destroyed, and a list of the elected officers, certified by the tellers, shall be preserved by the Secretary.

X.

MEETINGS.

The annual meeting of the Institute shall be held at such time as may be designated by the Council. The Institute may at a regular meeting select the place for holding the next regular meeting. If no place is selected by the Institute it shall be done by the Council.

Special meetings may be called whenever the Council may see fit; and the Secretary shall call a special meeting at the written request of twenty or more members. No other business shall be transacted at a special meeting than that for which it was called.

Notices of all meetings shall be mailed to all members at least thirty days in advance, with a statement of the business to be transacted, papers to be read, topics for discussion and excursions proposed.

No vote shall be taken at any meeting on any question not pertaining to the business of conducting the Institute.

Every question that shall properly come before any meeting of the Institute, shall be decided, unless otherwise provided for in these rules, by the votes of a majority of the members then present.

Any member may introduce a stranger to any regular meeting; but the latter shall not take part in the proceedings without the consent of the meeting.

XI.

PAPERS AND PUBLICATIONS.

Any member may read a paper at any regular meeting of the Institute, provided the same shall have been submitted to and approved by the Council, or a committee duly authorized by it for that purpose prior to such meeting. All papers shall become the property of the Institute on their acceptance, and with the discussion thereon, shall subsequently be published for distribution. The number, form and distribution of all publications shall be under the control of the Council.

The Institute is not, as a body, responsible for the statements of facts or opinion advanced in papers or discussions at its meetings, and it is understood, that papers and discussions should not include personalities, or matters relating to politics, or purely to trade.

XII.

AMENDMENTS.

These rules may be amended by a two-thirds vote taken by letter ballot in the same manner as is provided for the election of officers by letter ballot; Provided, That written notice of the proposed amendment shall have been given at a previous meeting.

THE SIXTEENTH ANNUAL MEETING, AUGUST 22d, 23d, 24th, 1911.

LOCAL COMMITTEES.

Transportation Committee, Dining Cars and Sleepers.

C. H. Watson, Wm. Kelly, O. C. Davidson.

Committee on Automobiles.

Iron Mountain—J. H. Karkeet, Geo. J. Eisele. Vulcan—F. H. Armstrong. Norway—J. B. Knight. Crystal Falls—Frank Scadden, Arvid Bjork. Iron River—G. L. Woodworth, Frank Youngs, W. H. Jobe.

Committee on Reception.

Norway—Doctor Miller, Gordon Murray, Capt. Wm. Bona, G. A. Hellberg, F. A. Janson. Iron Mountain—E. F. Brown, Martin Goldsworthy. Vulcan—A. W. Thompson. Loretto—C. H. Baxter, H. McLaughlin. Crystal Falls—Thos. Conlin, M. B. McGee, Arvid Bjork, Chas. W. Hughes, R. G. Whitehead, Captain Edwards, W. H. Fraser, J. S. Jacka, Herman Ruwitch, John Tufts, Capt. E. Pengilly, F. D. Ball, E. J. Oswald, Capt. E. Jacka, John Parks, E. S. Bridges, Chas. Neugebauer, W. H. Rezin, John Erickson, Sam Jacobs, Herman Holmes, Michael H. Moriarty. Iron River—E. S. Coe, J. S. Wall, I. W. Byers, M. S. McDonough, Victor D. Laing, J. H. Nettell, Wm. H. Bengry, H. E. Duff, John Looney, D. H. Campbell, Rudolph Erikson, W. H. Jobe, G. L. Woodworth, J. A. Monroe, O. P. Doty, Lowe Whiting, G. W. Youngs, S. D. Klinglund, F. A. Morrison, P. O'Brien, F. A. Dixon, W. H. Seldon, Walter L. Scanlan.

Committee on Finance.

W. H. Jobe, Chairman, E. W. Hopkins, J. D. Vivian, E. F. Brown, Rudolph Erikson, G. L. Woodworth.

ITINERARY.

The following itinerary has been arranged by the Committee in charge for the Sixteenth Annual Meeting to be held on the Menominee Range. This is subject to changes as circumstances may require.

Tuesday, August 22nd.

A. m. arrival and reception of visitors at Crystal Falls.

1:00 p. m. visit to Hollister Mine, inspecting new ore dryer, Tobin and Bristol Mines.

6:00 p. m. entertainment and luncheon by Crystal Falls Commercial Club.

8:00 p. m. business session at Court House.

Wednesday, August 23rd.

8:00 a. m. leave Crystal Falls in automobiles en route to the Iron River District, visiting the Chicagoan Lake, Swanson, Baltic, Caspian, James, Davidson, and other mines. At the Swanson, concrete shaft sinking will be seen.

Intermission for dinner at 12.

2:00 p. m. business session at Opera House; election of Officers for ensuing year.

6:00 p. m. entertainment and luncheon by Iron River Commercial Club.

Thursday, August 24th.

7:00 a. m. leave Iron River for Dickinson County points.

9:00 a. m. arrive Loretto. View changes in river course, and mining in the old river bed.

Automobile trip to Hydro-Electric Plant at Sturgeon Falls. Electric equipment and concrete lined shaft at Vulcan.

12:00 noon dinner.

1:00 p. m. automobile trip from Vulcan to Norway and Iron Mountain, visiting Chapin Mine, construction of dam at Twin Falls, and other points of interest.

5:00 p. m. disbandment.

HISTORICAL SKETCH OF MENOMINEE RANGE.

BY THOMAS CONLIN AND P. O'BRIEN.

DICKINSON COUNTY.

The Dickinson County end of the Menominee Range, being its easterly division, which also may be termed "the port of entry," was the first to be explored and developed, either for timber or iron ore. When the discovery of iron ore had been made on the Marquette range, and shipments begun some twenty odd years previous to the discoveries on the Menominee range, it was generally taken for granted that the ore already found limited the mineral resources of this part of the upper peninsula.

Some have also attributed the belated discovery of merchantable ore on this range to Indian superstition, thus keeping secret its known presence.

The opening of the Menominee range may be stated as being in 1870, when the first logs were cut, and floated down the Menominee river in 1871. Also in 1871, John L. Buell in company with John Armstrong made the first reported discovery of iron ore, and in 1872 the first exploring party entered this region under the guidance of Dr. N. P. Hulst, representing the Milwaukee Iron Company. The results of Dr. Hulst's discoveries were not made known. In 1873 the discovery made by Buell and Armstrong was explored and developed. In 1874 fifty-five tons of this ore was hauled to Menominee and smelted, the results being most satisfactory and gratifying. The first mining of iron ore and its smelting was followed by numerous explorations and the rapid development of mines in this county. The extending of the Menominee River Railroad in 1877 from Powers to Quinnesec was the entering wedge of this development era, and while explorations and discoveries have been going on from 1871 shipments cannot really be stated as having started prior to 1877. This railroad was extended to Iron Mountain in 1880, and thence in successive stages to the westerly division of the Menominee range, Iron County, becoming a branch of the Chicago & Northwestern system.

The following is a list of the earlier mines, date of discovery and date of first shipment:

	Discovery.	First Shipment.
Breen	1872	1877
Vulcan	1873	1877
Quinnesec	1877	1878
Emmett	1877	1878
Stephenson	1878	1879
Norway	1878	1879
Saginaw	1878	1878
Cyclops	1878	1879
Curry	1878	1879
E. Vulcan	1879	1879
Cornell	1879	1880
Kiel Ridge	1879	1880
Chapin	1879	1880
Indiana	1879	1880
Millie	1880	1881

It is not necessary to bring the above list down to date in this sketch as practically all the later day mines are to be found in statistical reports published in connection with the Institute proceedings.

Explorations for iron ore are still being carried on in Dickinson County but not on as extensive scale as at present in Iron County. The known iron ore resources on the easterly end of this range insures mining enterprises of magnitude for future generations.

A more extended sketch of Dickinson County could be written, but as this was covered in a previous Menominee

Range meeting* it is deemed advisable to give the westerly end of the range most of the available space at this time.

IRON COUNTY.

Crystal Falls gets its name from the falls in the Paint river, located close to the center of Sec. 20, 43-32.

The story is that in the middle seventies a crew of woodsmen. engaged in looking over and locating timber for a Menominee lumber company, was camped on Lot 3 of Section 20 a short distance above the falls. One morning in early October the sun arose bright after a sleet storm and as one of the cruisers looked out of his tent the sun's rays were reflected from the crystals that were suspended from the dense shrubbery that overhung the chasm about the falls. He remarked upon the crystal like appearance, and suggested that they call the rapids "Crystal Falls." That day the work was close to the falls and the men got to calling the place "the crystal falls in the Paint" which was afterwards abbreviated to "Crystal Falls."

At the falls in the Paint river the ore bearing rocks are exposed and the surveyors and cruisers made note of that fact. As the Menominee range was developed northwest from Waucedah, an advance guard of explorers penetrated the wilderness, like the skirmishers preceding an army, testing the earth by light test-pits. Among this advance body was "Jack" Armstrong, the first man to turn a shovel of dirt in the search for iron ore in the Crystal Falls district. Mr. Armstrong started his work on the banks of the Paint river a few feet from the edge of the cliff where the action of the water had exposed the formation. He was rewarded by meeting with some ore, the property being the same Lot 3, Sec. 20, 43-32 that has been explored by the International Harvester interests during the past two years. Armstrong was pressed closely by the Maltby brothers, who began operations on the lands adjoining his to the west in the vicinity of the Bristol mine

*Menominee Range—By John L. Buell, Vol. XI, 1905.

and they were really the discoverers of the Bristol-Youngstown deposit.

At this time the C. & N.-W. railroad was surveyed to Florence to which point it was being built to tap the ore district in that section. Among the contractors who were doing the grading was George Runkle and in his employ was S. D. Hollister. Mr. Runkle was closely connected with some of the Northwestern officials. He and Mr. Hollister visited Crystal Falls locality and Mr Runkle at once became convinced of its worth and induced Marvin Hughitt to personally visit this section to see for himself the possibilities of the locality and the advantage which the Northwestern would derive by extending its line right on through to Crystal Falls. Mr. Runkle was successful in his efforts and that winter the end of the road was pushed on to the Brule river instead of resting at Florence, a survey having been completed and adopted through to Crystal Falls.

In the meantime Messrs. Runkle, Hollister and others had secured options on the explorations and formed the Crystal Falls Iron company. The properties they took over were the Armstrong exploration on Lot 3, the Fairbanks, Kimball and others. While the road was being extended here more men were put at work in the pits and stories of the fabulous wealth of the section attracted other explorers, among them the Sheldons and Jacob Shafer who discovered the big deposit at the old Shafer. Another company headed by Mr. Hollister had discovered a big deposit on the N.-E. ¼ of S.-W. ¼ of Sec. 21, 43-32, the forty east of the Fairbanks. This discovery, taken along with the Fairbanks, led the Crystal Falls Iron company to believe that the big ore deposits existed to the east of the Paint river.

The Crystal Falls Iron company felt that the locality warranted the building of a town and began to look about for a site. They decided upon one of the banks of Runkle lake, close to the west line of Sec. 22, 43-32, and the original survey for the railroad contemplated the running of the main line to the shores of Runkle lake. In the meantime Mr. Shafer, operating on Sec. 31, had sold his find to the Union Steel company and right here comes the story of how Crystal Falls comes to be located on a side hill instead of upon the level plain about Runkle lake.

When the Union Steel company learned that the Crystal Falls people intended locating the town so far away from their mine they entered a protest which finally resulted in the threat of platting another town on Section 31—only 2½ miles away—in case the original idea of platting Crystal Falls on the banks of Runkle lake was carried out. The Crystal Falls people would not consent to locate the town on Sec. 31 and the Union Steel company refused to co-operate with the project if it was located on Sec. 21. The outcome was a compromise and the nearest piece of property that could be purchased just then was the S.-W. ¼ of N.-E. ¼ Sec. 29, 43-32. So, the property was purchased and the town platted on the side hill amidst inconveniences that were very hard to overcome. Before the controversy was settled the railroad grade had approached the locality and a portion of the approach to the proposed townsite on Runkle lake was graded and may be seen today near Railroad lake. The survey was changed, the road run to the new site and harmony reigned to the inconvenience of later generations.

Crystal Falls had the ups and downs experienced by the other iron districts during the 80's and 90's. The ore being of a lower grade than that of other sections, the explorers and operators attracted to this section were not as strong financially as in other sections and much hardship was experienced because of the irresponsibility of the mining companies during those days. The panic of 1893 acted as a cathartic to clear out the business system. Every property in the district was closed by that financial catastrophe and when they re-opened the ownership had passed to stronger hands.

The connection of the present operators dates from the renaissance of 1897 and subsequent years. Corrigan-McKinney & Co. was known in a small way previous to the panic under the old firm name of "Corrigan, Ives & Co." They were sales agents for some of the companies then operating mines in this section, principally the Mansfield mine under the old regime. In 1897 the new firm of "Corrigan, McKinney & Co." acquired the Crystal Falls mine which until that time had been in the hands of the Butlers of Youngstown, Ohio, and was not regarded as of much worth. They did but little further exploratory work before encountering the large ore deposit which extended to within a few feet of the surface. They immediately stripped the ore body and were enabled to produce ore very economically, a very necessary requisite in the stormy commercial period following the panic. With this property as a nucleus they extended their operations by the acquisition of the Great Western and Lamont mines; optioned and explored the Tobin, which they later developed into the magnificent property it now is. The Dunn they reopened by entirely new workings, made necessary by the caving of the old shaft. The Armenia, Fairbanks and Kimball were each in turn reclaimed by them, the old workings having been worked out or not warranting further work at the time they were abandoned. This company is today the owner of the major portion of the working properties in the district and won its position by banking its faith on the district when it was passed up by others.

Oglebay, Norton & Co., the owners of the Bristol mine, came here in 1898. They acquired a lease on the old Brier Hill which Schlesinger in his palmy days had stripped of its sand overburden at a great cost and which work was regarded as a marvel in those days. The Bristol people developed the property and made it the biggest producer in the district.

The Oliver Mining company came here first through the purchase of the old Columbia mine in 1902. Later on they acquired the Mansfield and Michigan by purchase and the Hilltop through the amalgamation of the American Steel

& Wire company. The Youngstown they acquired in fee through the Illinois Steel Co. Of their properties, only the Mansfield is now being operated at Crystal Falls and the Michigan at Amasa.

The M. A. Hanna people were induced through the efforts of Frank Scadden to take hold of the Hollister mine in 1907. They have operated continuously at that property since and in 1909 they took options to explore the Merry lands, one tract lying west of the Bristol where they are opening up the Ravenna mine, and the other tract, the old Monongahela, west of the Columbia. Recently they acquired the Harlow lands lying south of the Monongahela and are in position to become a large factor in the district.

The Youngs people were induced to take an option on a forty north of the Armenia three years ago and since then they have developed the MacDonald mine on that property.

In 1889 the Pickands-Mather interests were exploring the old Walpole at Iron Mountain. The outlook was not promising enough to them at the time so they came to this section and purchased an exploration on the banks of the Hemlock river in Sec. 4, 44-33. They transferred their equipment from the Walpole and succeeded in opening up the Hemlock mine which has been a steady producer since 1891 with the exception of a year or two during the panic of 1893. They platted a portion of their lands and called the place "Amasa."

Two years ago the Longyear & Hodge people began operations in this section, opened an office and later on organized the Nevada land company which has taken over several valuable properties upon which ore has been shown up by means of the diamond drill.

The Breitung people commenced exploratory work here last April and have mapped out an extensive program of exploration with a promise of success.

Iron River-Stambaugh.

The Iron River-Stambaugh district, or as it is generally called, the Iron River district, first became known in 1878 when Donald C. and Alexander Mackinnon arrived in the district from Negaunee, walking through the woods from Commonwealth, Wisconsin, the then terminal of the C. & N. W. Ry. These two hardy pioneers, believing that the district was eventually to prove a valuable one, located Section 26, 43-35, now known as the Village of Iron River. They also located the lands now known as the Kinney, Baltic and Youngs mines, and did some test pitting on these properties, but not sufficient to prove that they really contained the large bodies of ore which have since been shown up.

A recent geological report, published by Mr. R. C. Allen, director of the Michigan State Geological Survey, is authority for the statement that "the first discovery of iron ore in the Iron River district is accredited to Mr. Harvey Mellen, a United States land surveyor. The field notes of Mr. Mellen's under date of August 8th, 1851, describe the occurrence of an 'outcrop of iron ore five feet high' on the west face of Stambaugh hill, 52 chains north of the southwest corner of Section 36, T. 43 N., R. 35 W., and this outcrop was recorded on the original United States Land Survey plat of the township. While the occurrence of ore was thus early made known mining did not begin until 31 years later, when Mr. Mennen's discovery became the site of the Iron River mine," now known as the Riverton.

The Mackinnons explored the N. W. ¼ of the S. W. ¼, Section 36, 43-35, and opened up what is now the Beta mine. As there were no railway facilities the opening up of the property was necessarily slow. The ore was a low grade, running about 58.00 in iron and .25 in phosphorus. Following the development of the Beta came the opening up of the Nanaimo mine, after which the Village of Iron River was first named.

Following the Mackinnon brothers came R. L. and W. H. Selden in 1880 or 1881, as civil engineers of the C. & N. W. Ry. The latter gentleman, becoming imbued with the great future of this district, concluded that no better place for a home could be found, and together with his brother located lands in Section 35 and 36, 43-35, and immediately commenced active exploratory work, opening up the Iron River, Isabella, Selden and Hiawatha mines. The Iron River and Isabella mines were opened up and actively worked until 1888 or 1889, with Tod Stambaugh as general manager and J. N. Porter as general superintendent. In honor of the work done by Mr. Stambaugh, the Village and Township of Stambaugh was named after him.

In 1882 the district became prominently known to the outside world by the extending of the C. & N. W. Ry. from Commenwealth to Iron River, which remained its terminus for four years when it was extended to Watersmeet and the Gogebic range. Immediately on the extension of the railroad into Iron River ore shipments were made from the Iron River and Nanaimo mines.

Shortly after this time John S. MacDonald of Fond du Lac, Wisconsin, but now of Minneapolis, believed that a charcoal furnace would be a success in Iron River, as there appeared to be an unlimited quantity of iron ore and hardwood. Accordingly, in 1885, the work of erecting a sixty ton furnace was commenced and in 1886 was ready for operation. A number of charcoal kilns were erected near the furnace and also along the county road, on the farm now owned by M. B. Waite. The furnace from the start did not prove a paying proposition and in two or three years was forced into idleness, in which condition it remained until 1905 or 1906, when it became the property of Paul N. Minckler, who dismantled it and made it into a sawmill.

The Nanaimo and Iron River mines continued to ship ore until 1891, when the Nanaimo was closed down and remained closed until 1904. It was then reopened by the Mineral Mining Co. The Iron River mine shipped 1,176 tons of ore in 1892, was closed down and remained closed until 1903, when it was taken over by the Oliver Iron Mining Co., and has become a large producer.

For several years after the closing down of the above mentioned mines no operations were conducted in the Iron River district, particulary from 1893 to 1898 inclusive, owing to the low grade of the ore and the prevailing hard times.

The homestead law was also a determining factor in preventing the development of the district. As the question of title was at stake no mining company cared to expend any money in exploratory work without knowing in whom the title to the land rested. As rapidly as the ownership to the land was settled exploratory operations became more numerous until at present there is not another district in the entire Lake Superior region of similar area that can boast of so many mining companies in operation.

Following the opening of the Nanaimo and Iron River mines, came the developing and opening up of the Sheridan, Hiawatha, Dober, Baltic, Caspian, James, Young, Baker, Fogarty, Berkshire, Chathams, Zimmerman, Chicagoan, and Davidson mines. Besides there are a number of promising explorations which will within the next year or so be added to the shipping list.

The following well-known companies are now actively engaged in the Iron River district:

Oliver Iron Mining Co.	Republic Iron & Steel Co.
Verona Mining Co.	Davidson Ore Mining Co.
Corrigan, McKinney & Co.	Jones & Laughlins Co.
Oglebay, Norton Co.	Mineral Mining Co.
Rogers Brown Ore Co.	Florence Iron Co.
Youngs Mining Co.	Wickwire Steel Co.
Cleveland-Cliffs Iron Co.	Michigan Iron Co.

Iron River Ore Co.

Of these fifteen companies, seven are already shippers and have been for a number of years. The future of the Iron River district never looked brighter than at present.

DESCRIPTION OF MINES ON THE MENOMINEE RANGE.

THE OLIVER IRON MINING COMPANY.

CHAPIN MINE.

The Chapin Mine is located in Iron Mountain, Michigan, and is a property of the Oliver Iron Mining Company, and has been in operation since 1879.

The Chapin has three shafts, the "B" Chapin, No. 2 Hamilton and "C" Ludington. "B" Chapin is at this time idle on account of alterations being made to its hoisting plant. No. 2 Hamilton, since the sinking of "C" Ludington was completed, has been used for hoisting and lowering men and timber only. Pumps are also located on the 12th and 16th levels of this shaft, which, until the Cornish pumping plant was placed in operation, were used for pumping all the coming water in the Chapin Mine.

Since the date of the last meeting of the Institute on the Menominee Range (1905), a few changes have taken place in the way of equipment at the Chapin, which might here be briefly described. The sinking of "C" Ludington shaft has been completed. At this shaft the entire product of the mine is hoisted, and here, also, the greater portion of the pumping from this property is carried on. "C" Ludington shaft is 10′ 4″ by 21′ 3″; is steel lined and has a depth of 1,522 feet, or is down to what is known as the 17th level. The shaft has two skip compartments, each 5′x6′; one cage, 5′x10′ 4″, and one compartment 9′ 3″x10′ 4″, used for ladderway, pump columns, air lines, electric wires, etc. Two five ton skips are operated in this shaft; the product of the mine being hoisted from what is termed the 14th, or main working level, and which is located 1,201 feet from the surface. The equipment at "C" Ludington shaft consists of one 34x72 inch single duplex first motion Corliss hoisting engine, operating single drum, 12' diameter, 10' face, grooved for 1⅜" rope and is used as a skip hoist, and one 30x60 inch simple reversible Corliss hoisting engine, geared to one 12' drum, 10' face, grooved for 1⅜" rope, and used as Cage hoist. Electric generator plant for operating underground electric haulage consists of one 100 K. W. direct current, 250 volt, 400 ampere belt driven generator, driven by 14"x36" Corliss engine, and one two unit, three bearing induction motor generator set, 200 K. W. 250 volt, 800 ampere. The boiler plant consists of four 72"x15' horizontal tubular boilers. As all the machinery described above is operated with compressed air, this plant is used only in case of emergency.

At this shaft there has also been installed, and is now in operation, a Cornish pumping plant, which, some 15 years ago, was located in "D" shaft Chapin Mine. This plant may be described as a Steeple Compound engine with high pressure cylinders 50 inches diameter, low pressure 100 inches diameter, stroke 120 inches and fly wheel 40 feet in diameter, weighing 160 tons. The pump is of eight-lifts construction, six sets each 192 feet apart and two sets each 170 feet apart. Plungers and discharge column 28 inches diameter, pump rods 7" and 8" diameter. Capacity of pumping plant 3,000 gallons per minute from depth of 1,500 feet. For operation of the pumping plant, there have been installed six 72"x18' horizontal tubular boilers. The building containing these boilers is one of the standard type of the Oliver Iron Mining Company.

Chapin Mine Compressor Plant.

Mention might also here be made of the Chapin Mine air compressor plant, located at what is known as the Upper Quinnesec Falls, on the Menominee River, about three miles southeast of the mine. This plant was installed in the year 1882. During the years 1903 and 1904, and subsequent to this time, some changes were made in the plant, one of which consisted of building a steel flume to replace the wooden flume originally built. This new flume has a length of 382 feet, is 16 feet deep and 22 feet wide and is supported by 72 concrete piers.

New air cylinders of the Corliss valve type, have also been installed, three pair being 34"x60", and one pair 38"x60" in size, replacing three pair 34"x60" and one pair 36"x60" of the old poppet valve type. Each pair of the cylinders are driven by 50" special double horizontal turbines. A pipe line 24" in diameter, conveys the compressed air to the mine a distance of 16,665 feet. This pipe is built in lengths of 58 feet each, the material being riveted wrought plates ¼" in thickness. At the present time, all machinery at the Chapin Mine, with the exception of the Cornish pumping plant, is operated by compressed air.

Aragon Mine.

The Aragon is another of the Oliver Iron Mining Company's properties, and is located in the City of Norway, Michigan. This mine is operated by two shafts, Nos. 4 and 5.

No. 4 shaft has a depth of 991 feet. It has three compartments, two for skips and one for pipes, ladderway, etc. The equipment at this shaft consists of one 20"x42" simple duplex first motion, hoisting engine, operating two drums each 6 feet in diameter with 9 foot face. One Corliss cross-compound steam, single-acting, four stage air compressor, steam 12"x 22"x30", air 20"x12"x7¼"x4¼"x30", providing air for pneumatic haulage plant in use at this mine. One simple steam, three stage tandem air compressor, steam 14"x16", air 10½"x7¾"x3⅝"x16", first installed for furnishing air for pneumatic haulage, now used as relay only. One 17½ K. W. direct current, 125 volt, belt driven generator for lighting purpose on surface. The boiler plant at No. 4 consists of three 264 H. P. Babcock & Wilcox water tube boilers.

No. 5 shaft has a depth of 1,052 feet and has four compartments, two compartments for skips of five-ton capacity each, one for cage and one for pipes, ladderway, etc. On the

11th level at this shaft are located two 18"-28"-47"-12"x24" triple expansion pumps. The equipment on surface here consists of one 28"x60" simple duplex, first motion Corliss hoisting engine, connected to two 12 foot drums—each 9 foot face and used for operating two five-ton skips. One 24"x42" simple Corliss hoisting engine, geared to one 12 foot drum, diameter of face 5½ feet and used for operating cage. There are also located at No. 5 shaft two compressors, one tandem compound, two stage, steam 18"x36", air 20"x32"x36". One straight line simple two stage air compressor, steam 20"x26", air 22"x14"x26". The boiler plant consists of two 264 H. P. and one 400 H. P. water tube boilers.

Since the last meeting of the institute, a new machine, blacksmith and carpenter shop has been built in close proximity to No. 5 shaft. A new laboratory, a changehouse with capacity for 350 men, saw mill, oil house and captain's office have also been erected. Old buildings of same nature as those mentioned, were formerly located near what was known as No. 2 shaft. This shaft has been abandoned on account of the ground caving, which also made necessary the construction on a permanent site for the buildings above noted.

MANSFIELD MINE.

The Mansfield is the property of the Oliver Iron Mining Company located at Mansfield, Iron County, Mich., about seven miles east of Crystal Falls.

Geologically, the Mansfield ore body stands alone. It is not of the same age as the Amasa, Crystal Falls or Iron River ore bodies nor the ore bodies at Iron Mountain and east. It lies in a thin slate formation, above and below which is greenstone. There are other slates east of the Mansfield mine which are of the same geological age as the Mansfield slate, but they are not so enclosed by greenstone. The ore body strikes nearly north and south and dips west at a high angle. It is about eleven feet thick, and very uniform, and is fairly persistent with depth. It is spoken of by many as a true fissure vein, and looked upon as an eruptive, but the ore was concentrated in exactly the same way as were the other iron ore bodies of Michigan. Elsewhere the Mansfield slates have not produced ore.

The mine is operated by one shaft, known as No. 2, and has a depth of 1,390 feet. It is vertical and has three compartments, two for skips and one for ladderway, pipes, etc. The skips in this shaft are suspended from single deck cages, which are used for hoisting and lowering men. The equipment here consists of one 28"x48" simple reversible Corliss hoisting engine, geared to two drums, each 10 feet in diameter with 6½ foot face. One simple duplex slide valve, two stage air compressor, steam 18"x24", air 28¼"x17¼"x24". The boiler plant consists of three 72"x18 ft. horizontal tubular boilers.

MICHIGAN MINE.

The Michigan is located at Amasa, Iron County, Mich., and is operated by the Oliver Iron Mining Company.

This property is in the same geological formation as is the Dober. To the East, which would be in its footwall, is a magnetic slate which can be readily traced with the magnetic needle, though the magnetic dip is not large. This slate is in the footwall of the Hemlock and Gibson also. East of the magnetic slate is the Hemlock greenstone. The Michigan formation dips west at a high angle and the strike is nearly north and south. The ore is high in phosphorus, as are the other ores of the same formation. The mine is operated through one shaft, known as No. 2. This shaft is incline and has three compartments, two for skips and one for ladderway, pipes, etc. The equipment at this shaft consists of the following: One 12"x14" simple duplex slide valve reversible hoisting engine, geared to drum 6 feet in diameter with face 4' 8", one straight line, simple steam, single stage air compressor, steam and air cylinders 12"x30" and one 250 H. P. water tube boiler.

DOBER MINE.

The Dober mine is operated by the Oliver Iron Mining

Company and located at Stambaugh, Iron County, Michigan.

The Dober formation strikes west of south and is nearly vertical. It has a black slate footwall, as have all the other mines of the Iron River area. It is separated from the Isabella ore body adjoining the Dober on the north by a black slate. It is, however, possible that future work will show that the Isabella and Dober formations are really one, and that their present apparent relations are due to folding. The Dober ore body lies in a formation which is geologically younger than the slates, in which are found the ore bodies at Iron Mountain and east. Like other ore bodies of the Iron River area, the Dober is high in phosphorus. It is difficult to say what part the black slate footwall played in the concentration of ore, but since every mine in the area has black slate, either in foot or hanging wall and sometimes both, it is quite evident that the presence of black slate is almost a necessary condition for a mine in the Iron River area.

There are two shafts in operation at Dober mine: Nos. 1 and 2. No. 2 is incline, has three compartments and is down to a depth of 685 feet. Two four-ton skips are operated in this shaft. The equipment at this point consists of one 18"x48" simple single reversible Corliss hoisting engine, geared to two drums each 8 ft. in diameter with 5 ft. face and one simple duplex Corliss, two stage air compressor, steam 18"x30", air 28"x18"x30". No 1 shaft has one compartment only and is down to a depth of 800 feet, equipped with cage for hoisting and lowering men. The cage is also used for hoisting some ore with car. The hoist for operating this cage is described as one 18"x24" simple duplex slide valve reversible engine, geared to one drum 6 ft. in diameter with 6 ft. face. One boiler plant provides steam for equipment at both shafts above described, and consists of three 250 H. P. water tube boilers.

Cundy Mine.

The Cundy is the property of the Oliver Iron Mining Company and is situated at Quinnesec, in Dickinson County, Michigan. This mine is located in what is generally known as the Curry member of the Vulcan iron bearing formation, despite the fact that most of the ore bodies east of Iron Mountain are in the Traders' member. The dip of the ore body is about 70 to 80 degrees toward the south, which is away from the dolomite, although the Chapin dips to the north toward the dolomite. The ore is hard and lean, and shows the fragmental nature more plainly than is common along the range. The ore body carries a considerable amount of magnetite.

Two shafts are located on this property; one known as the "Gray," and the other the "Foote," the former 495 feet and the latter 615 feet in depth. The equipment at the Cundy mine consists of one 24"x48" simple, non-reversible, Corliss hoisting engine geared to two drums, each 8 feet in diameter with 6½ foot face, and three 72"x20' horizontal tubular boilers. This property was closed down in October, 1903, and has not been in operation since that date.

O. C. Davidson, Iron Mountain, Mich., is general superintendent of the properties operated by the Oliver Iron Mining Company.

THE MUNRO IRON MINING COMPANY.

THE ROGERS MINE.

The Rogers Mine, located on the N. E. ¼, Section 29, 43-34, is under lease to the Munro Iron Mining Company. The property has been partially explored by diamond drilling. A concrete shaft sunk by the Foundation Company is now down to ledge and the active development of the property will soon be started. The concrete part of the shaft has a circular exterior with 16' 6"x11' 0", rectangular interior, which will be divided into two skip roads, a cage road and pipe and ladder compartment. No permanent equipment has yet been installed.

THE CHICAGOAN MINE.

The Chicagoan Mine is located on the Northeast quarter of Section 26, 43-34 about seven miles east of Iron River and is operated by the Munro Iron Mining Company. Although first explored in 1881 the property was not brought to the shipping stage until this season. The old exploring shaft has been sunk to a total depth of 540 feet and the ore measures explored by three main levels, the 2nd, 3rd and 5th. The sub-level stoping system of mining is used. The mine is equipped with three 150 H. P. boilers; one No. 8 crusher, and temporary air compressors and hoist. Total shipments to August 1st 70,000 tons.

The Hiawatha Mine.

The Hiawatha Mine, located on the S. W. ¼ of the S. E. ¼, Section 35, 43-35 is owned in fee by the Munro Iron Mining Company who began work on the property in 1906. The shaft has been sunk to a total depth of 790 feet with levels approximately one hundred feet apart, the seventh or bottom level being at a depth of 757 feet. The sub-level stoping system of mining is used to a large extent. The surface equipment consists of four return tubular boilers, 22"x48" Allis Chalmers first motion hoist with 7 ft. drum, 2,000-ft. Nordberg cross compound air compressor, McEwen D. C. generator, and a No. 8 McCully crusher. Tramming is done by electricity. The mine is provided with a one 1,200 gallon Prescott crank and fly wheel pump and one 1,000 gallon Prescott triple expansion pump. The yearly output is about 130,000 tons. Total production previous to 1911, 614,496 tons.

The Munro Mine.

The Munro Mine located one and one-fourth miles west of Norway on Section 6, 39-29 is leased by the Munro Iron Mining Company. Mining is by the open pit milling system. Owing to the low grade of the ore, only a limited product is desired. Total production to date, 298,578 tons. Equipment consists of two 150 H. P. return tubular boilers, geared hoist and straight line air compressors, and a No. 7½ crusher.

G. L. Woodworth, Iron River, Mich., is in charge of the several properties of this company.

THE DESSAU MINING COMPANY.

This company operates the Millie Mine located on the N. E. 1/4 of the N. W. 1/4 and the N. W. 1/4 of the N. E. 1/4 of Section 31, Town 40, Range 30. This mine was first opened in the early eighties and has shipped to January first 368,267 tons. This product with the exception of 113,650 tons, mined from an open pit at the west end of the property, was a high grade Bessemer ore. The Main shaft is 350 feet in depth.

S. J. McGregor, Iron Mountain, Mich., is in charge of the property.

LORETTO MINE.

Located in Section 7, T. 39 N., R. 28 W., between the northern and southern belts of dolomite. Operated by the Loretto Iron Company. As the Sturgeon River formerly passed over the ore body, mining was conducted by the room and pillar system to a depth of 800 feet. In 1908 the course of the river was diverted to the west of the ore body and operations since that time have consisted of mining out the pillars by the top slicing system. There are two shafts in use, No. 1 hoisting shaft 6x12 feet, 800 feet deep and No. 3 timber shaft 8x10 feet, 300 feet deep. The boiler plant consists of two 76″x20′ and 72″x20′ horizontal tubular boilers, and one 10′ 6″x12′ 6″ Scotch marine boiler. The mechanical equipment consists of one Bullock 21″x36″ direct acting flat rope hoist, one Webster, Camp & Lane 10″x14″ geared hoist, one 16″x30″ and 30″x19″x42″ cross compound Rand compressor and a 10″x18″ and 11½″x7″x5½″x3⅜″x12″ Laidlaw-Dunn-Gordon high pressure air compressor.

APPLETON MINE.

Operated by the Loretto Iron Company and included in the description of the Loretto Mine. J. Ward Amberg of Chicago is manager.

CORRIGAN, McKINNEY & CO.

Several of the mining companies operating on the Menominee range, particularly in Iron County, are under the control of Corrigan, McKinney & Co. The active mines at the time of the Institute meeting were the Tobin, Dunn, Armenia and Tully; the idle mines were the Great Western, Crystal Falls, Kimball, Fairbanks and Baker. The operations are under the charge of Wm. J. Richards, general superintendent, Crystal Falls, Mich.

TOBIN MINE.

The Tobin Mine has been opened to a depth of 1,100 feet, mining now to the eleventh level. From this level a winze has been sunk another 125 feet and crosscutting is now in progress to the shaft, thus making the twelfth level. This mine is electrically equipped, having electric haulage on the stockpile and underground. The main shaft is 6′ 6″x22′ inside measurements, and four compartments. The main hoist is a twin Corliss Nordberg 20″x48″, first motion. The man and timber hoist is a Marinette 16″x20″, geared. The compressor is the Rand Imperial type of twenty-five drill capacity. The boilers are horizontal return tubular, four in the battery, with a total of five hundred horse power. At this plant the Green Fuel Economizer has been installed. Underground the water is handled by a Prescott triple expansion pump of 750 gallons capacity, with a Prescott compound of 500 gallons capacity as a relay. All the ore hoisted is crushed.

DUNN MINE.

The Dunn is one of the oldest mines in Iron County. The bottom level is the eleventh, at a depth of 1,420 feet. The shaft is three compartment, 6′ 4″x16′ 4″ inside. All ore hoisted is crushed before going on the stockpile or into the cars. The hoist is of the Sullivan Corliss type 20″x48″, first motion. A new compressor made by the Chicago Pneumatic Tool Company was recently installed, and is a Corliss two stage design, 20″x34″ steam, 17″x28″ air, with piston stroke of 36″, or a drill capacity of about 25 machines. This mine has underground electric haulage and also electric haulage for stocking on surface. The boiler battery consists of horizontal return tubular boilers, three of 150 horse power each and one of 125 horse power. The underground water is handled by a Prescott compound pump of 500 gallons capacity.

ARMENIA MINE.

The Armenia mine is now working on the seventh level or a total depth of 690 feet. The shaft is 6′ 4″x16′ 4″ inside, four compartments. The main hoist is a Fraser Chalmers, 22″x48″, geared type. The man and timber hoist is a Marinette 18″x24″. This mine has a crusher equipment and all its ore is crushed. A Rand duplex two stage compressor furnishes air for twelve machines. The boiler plant consists of three 150 horsepower horizontal return tubular boilers. The mine water is handled by a Prescott triple expansion pump with a capacity of 1,000 gallons at 1,000 feet. The haulage equipment at this mine, both underground and on top, is electrical.

GREAT WESTERN MINE.

Although the mine is at present idle considerable activity prevails on surface. At this mine is located the general shops of the Corrigan, McKinney & Co. group, the general store house, and the general office. Hence, a fair force is kept continually engaged here.

TULLY MINE.

The work at the Tully consists in sinking a shaft from surface through the overburden of 160 feet to the ledge. This work is almost finished, after sinking through 80 feet of hard pan, then through 80 feet of quicksand and handling 1,200 gallons of water per minute. This mine, as well as all the idle mines of the Corrigan, McKinney & Co. control, has complete surface equipment.

THE FLORENCE MINE.

Located on a hill northwest of the village of Florence, Wisconsin, covering the N. E. ¼ of S. E. ¼ and S. E. ¼ of N. E. ¼ of Section 20 and the N. W. ¼ of S. W. ¼ of Section 21 in Township 40 North, Range 18 East.

The ore is a medium hard, red hematite. The formation is very wide; slightly bowed and folded. The ore occurs in large lenses of irregular shape. It is mined by the underhand stoping system, milling into raises from below. Floor pillars are left every second level which are afterwards blasted out. This leaves very large stopes some of which are 250 feet long, from 50 to 150 feet wide, and 200 feet high. In the old part of the mine, these stopes are being filled with sand in order to mine the pillars which contain a large amount of good ore. The sand filling is done with a Bagley Steam Grader operated by three men. This grader handles more dirt in twenty-four hours than would be possible with a steam shovel working under similar conditions. The tramming underground is done by three electric motors working on 500 volts, direct current. The deepest level is 670 feet.

The main items of interest at the mine is the crusher plant which is a No. 7 Gates, set on a concrete foundation. The ore being elevated by means of a belt elevator and trammed to the stockpile with an electric motor in the winter time. In the summer time, the ore is emptied directly into the pockets from the elevator. The mine has been closed since the first of June, this year.

Felix A. Vogel, 25 Broad street, New York city, is the general manager; E. S. Dickinson, superintendent, and Edward Larson, assistant superintendent.

BRISTOL MINE.

The Bristol mine is located in the E ½ of the S ½ of Section 19-43-32 about 1½ miles from the city of Crystal Falls. The mine was originally called the Claire, but was leased in 1889 by the Bristol Mining Co. and renamed the Bristol. The first shaft was 960 feet deep and is being replaced by a steel lined 4-compartment shaft, which will be put down to a depth of 1,000 feet. A Webster, Camp & Lane hoist and a Norwalk tandem compound compressor are the equipment at the old shaft. Two grades of ore are shipped; the Manganate ore containing over 3 per cent. manganese, and the Bristol running higher in iron and lower in manganese. Total output to January 1st, 1911 is 2,456,109 tons.

E. W. Hopkins is General Manager and Arvid Bjork, Superintendent.

BUCKEYE MINE.

The Buckeye mine is located in Section 33-40-18 in the Wisconsin portion of the Menominee Range, in the Town of Commonwealth. It is worked by the Reserve Mining Co. under a lease from the Commonwealth Iron Co. and was opened in 1908. The shaft is down 495 feet and four levels have been opened up. The hoisting plant is the Sullivan automatic slide-valve type, the compressor a Sullivan straight line corliss. During the last year the mine buildings have been rebuilt and the equipment is very complete. The total production to date is 187,775 tons.

E. W. Hopkins is general manager and Frank J. Smith, superintendent.

BRULE MINING COMPANY.

CHATHAM MINE.

The Chatham Mine is located in the N. E. ¼ of the S. E. ¼ of Section 35, 43-35 in the village of Stambaugh in the Iron River district, and is operated by the Brule Mining Company. A Sullivan automatic slide valve hoist has been recently installed. The compressor is a Sullivan straight line corliss. The mine is operated from two shafts, one on each side of the Iron River; No. 1 having a depth of 700 feet and No. 2 a depth of 300 feet. A great deal of pumping is necessary owing to its close proximity to the river.

BERKSHIRE MINE.

The Berkshire Mine is located in Section 6, 42-34 in the village of Stambaugh in the Iron River district. The mine was opened in 1908 by the Brule Mining Company. The workings are operated from a single shaft which has a depth of 365 feet. A Sullivan automatic slide valve hoist has been recently installed, and air for drills is furnished by a Sullivan straight line corliss compressor. Total production to date is about 200,000 tons.

E. W. Hopkins, Commonwealth, Wis., is general manager and F. D. Klinglund, Stambaugh, Mich., superintendent.

GROVELAND MINING COMPANY.

In 1881 exploring was begun on what is known as the Groveland Mine, located in the N. E. ¼ of S. W. ¼ and N. W. ¼ of S. E. ¼, Section 31, 42-29, Dickinson County, by the Felch Mountain Mining Company, a subsidiary of the Old Menominee Mining Company, and continued by them until 1885 when it was abandoned. The work consisted of pits, trenches and shallow drill holes. In 1887 W. H. Rand of Chicago organized the Groveland Mining Company, and equipped the property for active mining. A small shipment of ore was made to Joliet, Ills., in 1888 and again in 1889. The ore being too low grade to be disposed of at this time, shipments were stopped and exploratory work carried on until 1892 when the company suspended operations. It remained closed until 1901 when it was reopened by Corrigan, McKinney & Co., and abandoned by them in 1905. In 1907 it was again opened by G. W. Youngs who organized the present Groveland Mining Company, the present operators. Shipments of ore have been made for the past four years without interruption and to date the mine has shipped about 140,000 tons. The equipment consists of four 60 H. P. boilers, one 12"x16" Lake Shore Engine Works geared hoist, one 20"x16½"x28"x 24" Franklin compressor and one No. 7½ Gates crusher. F. W. Youngs of Iron River is superintendent.

McDONALD MINING COMPANY.

The McDonald Mine is located in the S. E. ¼ of the N. E. ¼ Section 23, 43-32 in the Crystal Falls district and lies north of the Armenia Mine. The property is in its development stage, a 12'x8' shaft is being sunk its present depth being 318 feet. Work was started in 1908, and in 1909 a small cargo was shipped. Ore lenses of a very encouraging nature have been found above the 300 foot level which are widening with depth. The equipment consists of two 150 H. P. horizontal boilers, one 12"x14" geared hoist and one 16"x14"x24" x18" Franklin air compressor. F. W. Youngs, Iron River, is superintendent.

HURON IRON MINING COMPANY.

The Youngs Mine is located in the E. ½ of Section 12, 42-35 in the Iron River district and adjoins the Baltic Mine on the west and the Fogarty on the south. The property was opened in 1905 by G. W. Youngs and 11,000 tons were shipped that year. In 1907 it was sold to the Huron Iron Mining Company, the present operators. It has one working shaft 425 feet deep, through which a four-ton skip is operated. The equipment consists of three 150 H. P. horizontal boilers, one 15"x20" Lake Shore Engine Works geared hoist with 6 foot drums, one Ingersoll Rand 15 drill compressor and one No. 7½ Gates crusher. F. W. Youngs is superintendent.

PEWABIC COMPANY.

This company operates the Pewabic Mine near the City of Iron Mountain. It is one of the oldest companies on the Menominee Range, and in point of total shipments is the third largest producer. The Pewabic includes the old Walpole and Keel Ridge Mines. The local office of the company is at Iron Mountain. Mr. E. F. Brown is manager and W. G. Munroe assistant superintendent.

MINERAL MINING COMPANY.

The general mine office of this company is at Iron Mountain, Michigan, and E. F. Brown is secretary and general manager. The operations of this company at the present time consist of the following mines:

WAUSECA MINE—N. ½ of N. E. ¼, Section 23-43-35.

OSANA MINE—S. W. ¼ of N. E. ¼ and S. E. ¼ of N. W. ¼, Section 23-43-35.

NANAIMO MINE—N. W. ¼ of S. W. ¼ and S. W. ¼, of S. W. ¼, Section 26-43-35.

BREEN MINE—N. W. ¼ of N. E. ¼, N. W. ¼ of N. W. ¼ and N. E. ¼ of N. W. ¼, Section 22-39-28.

ANTOINE ORE COMPANY.

This company is operating the Clifford-Traders Mine, located on Sections 17 and 20, Town 40, Range 30, near Iron Mountain. The mine is worked open pit and the present depth of the shaft is 135 feet. The ore is crushed before being shipped, a No. 7½ Gates crusher handling the product as mined. Frank Carbis of Iron Mountain is superintendent.

PICKANDS, MATHER & COMPANY.

The operations of this company in the Lake Superior district, are under the charge of C. H. Munger, general manager, Duluth, Minn. The Menominee Range properties, under the charge of Charles E. Lawrence, general superintendent, Iron Mountain, consists of the following mines:

BALTIC MINE.

The Baltic mine is located on the W. ½ of the N. W. ¼ of Section 7, Town 42, Range 34. The ore is a brown hematite, and is mined by the sub-stoping method. The mine is thoroughly equipped with machinery, has forty-four dwellings and a modern fireproof dry house, equipped with steel lockers, baths, toilets and emergency hospital. It also has a club house for the benefit of the Company's employees, which is equipped with bowling alleys, baths, barber shop, pool and billiard room with a large and well lighted reading room, is stocked with papers and magazines, together with a graphophone and pianola. The mine is opened to the 7th level, 585 feet vertical depth, and is operated through two shafts, one being used for ore and the other for the handling of men and timber. The first shipment of ore was made in 1901 and the mine is the pioneer of the district around Palatka.

FOGARTY MINE.

The Fogarty mine is located on the S. E. ¼ of the S. E. ¼ Section 1, Town 42, Range 35. The ore is a brown hematite, and like the Baltic is mined by the sub-stoping method. The property is fully equipped with machinery and has a fire-proof dry house with steel lockers, baths and emergency hospital. The mine is opened to the 3rd level, at a depth of 265 feet vertical, and is operated through two shafts, one for the handling of ore and the other for the handling of timber and men. The first shipments were made in 1907.

CASPIAN MINE.

The Caspian mine is located on the N. E. ¼ of Section 1, Town 42, Range 35. The ore is a brown hematite, and the method of mining is the slicing or caving system. The property is thoroughly equipped with machinery. It has sixty-eight dwellings, and the company is at present erecting a handsome and modern club house for the use of its employees. The mine is opened to the 3rd level, being 292 feet deep, vertically, and is operated through three shafts, one being for the handling of ore and the other two for men and timber. The first shipment was made in 1903.

BENGAL MINE.

The Bengal mine is located on the N. ½ of the S. E. ¼ of Section 36, Town 43, Range 35. The ore is a brown hematite. This property at present has merely an exploring shaft with an equipment of exploring machinery and buildings on surface. A new shaft is being sunk, which, when completed, will be equipped with modern machinery. The work of exploring to date has been confined to one level.

W. H. Jobe is superintendent of the Baltic, Fogarty, Caspian and Bengal mines, all of which are located near Palatka, in the Iron River district.

HEMLOCK MINE.

The Hemlock mine is located on the W. ½ of the S. W.

¼ of Section 4, Town 44, Range 33, near Amasa. The ore is a red hematite, extremely hard, and the back-stoping system is here applied. The property is thoroughly equipped with machinery and mine buildings, among the latter being a modern fire-proof dry house, with steel lockers, baths and emergency hospital. The Company has twenty-seven dwellings for the use of employees. The product is secured from one shaft, the mine being opened to the 14th level, at an angle of 65 degrees, depth, 1,200 feet. The first shipments were made in 1891. C. W. Hughes is superintendent.

CHANNING MINE.

The Channing mine is located on the S. E. ¼ of Section 20, Town 45, Range 33, north of Amasa. The ore is a red hematite. The property has never been worked as a mine, although the ore body has been developed, ready for mining, but is of low quality. The mine is closed down at present. The equipment is of an exploratory nature. R. G. Whitehead is superintendent.

VIVIAN MINE.

The Vivian mine is located on the S. W. ¼ of Section 34, Town 40, Range 30, near Quinnesec. The product is a silicious ore, and the mode of mining is back-stoping. The ore is secured through one shaft and the mine is opened to the 4th level, at a vertical depth of 310 feet. The first shipment was made in 1902. The mine is equipped with necessary machinery and mine buildings, together with five dwellings for employees. The property is closed at present.

CALUMET MINE.

The Calumet mine is located on the N. E. ¼ of Section 8, Town 41, Range 28, south of the Metropolitan district. The ore is silicious and the mode of mining is back-stoping. The product is secured through one shaft, and the mine has been opened to the 3rd level, at a vertical depth of 215 feet. The property is equipped with the necessary machinery and has twenty-four dwellings. The mine is closed at present. The first shipment was made in 1906.

PENN IRON MINING COMPANY.

The Penn group of mines were developed in 1879-81 by the Menominee Mining Company and acquired by Penn Iron Mining Company in 1882. The total production to December 31st, 1910, is 8,845,135 tons. The operations of the company are divided into three departments—East Vulcan, West Vulcan and Norway.

EAST VULCAN MINE.

At the East Vulcan there are two shafts, No. 4, 1,450 feet deep, and No. 3, 1,150 feet deep, and the East Central adit which reaches some small ore bodies near the surface at the west end of the operations. The largest of these has been connected below with drifts from No. 3 shaft. In this ore body the top stoping and caving method, from sub-levels, about fifteen feet apart, is used, but in most other parts of the mine where the ore body is very irregular in shape the ore is taken out in over-hand stopes with square sets or stull pieces and generally filled with waste rock. In some cases the stoping is in the form of rooms and pillars. The mine makes from 700 to 800 gallons of water per minute which is pumped from the bottom of No. 4 shaft. This property at the present time is producing at the rate of from 80,000 to 100,000 tons of ore a year.

WEST VULCAN MINE.

The West Vulcan department includes, from east to west —No. 7 shaft, 265 feet deep; C shaft, 1,500 feet deep; Curry shaft, 1,350 feet deep, and Brier Hill shaft, 810 feet deep. Brier Hill shaft is circular in section, 14 feet in diameter, and lined throughout with concrete with steel dividers to hold the runners. The constructon of this shaft is described in the Proceedings of 1909, Vol. XIV, pages 140-147. This department is producing at the rate of between 200,000 to 250,000 tons of ore a year. About 30 gallons per minute of water is pumped from the bottom of the Brier Hill shaft and 900 gallons per minute from the bottom of C shaft. There are steel head-frames over Curry and Brier Hill shafts and a fire-proof changing house with lockers and toilet arrangements at Brier Hill.

The ore on the lower levels east of C shaft is being taken out by top slicing. In most of the other parts of the mine the system is by rooms and pillars, using square sets with rock filling in the rooms, and square sets, sometimes in side slices with filling, or top slicing in the pillars. The timber system is used where it is necessary to hold up the surface or where the rock over the ore will not cave. The irregularity of some of the ore shoots is such that no caving plan will apply. Where the walls are very strong shrinkage stoping is sometimes used. The square set methods are described in a paper by F. L. Burr in another part of these Proceedings. The workings connecting the four shafts at different levels extend for over a mile from east to west. At both East and West Vulcan there are geologically two ore formations with slate of varying thickness up to four hundred feet between. In some cases the formations have been so folded as to appear in crosscuts to be duplicated. The ore is sometimes found in major folds, but sometimes the folding is of minor importance. Continuous exploring underground is required to trace the known ore bodies or discover new ones. Even in the larger ore bodies their continuance in depth is very uncertain.

NORWAY MINE.

The old Norway mine was idle for a number of years, but the pillars and floors are now being taken out and this will not take very long. Exploring by drifting underground and diamond-drilling from surface is being prosecuted. The old Cyclops pits are worked on an open pit milling system for silicious ore in the summer time.

HYDRO-ELECTRIC PLANT.

In 1905 and 1906 a hydro-electric plant was constructed at the Sturgeon Falls of the Menominee River, and practically all of the mine machinery is, or soon will be, driven electrically. The steam pumps which were installed before the electrical pumps were put in are still in place and the engines of two of the hoists can still be connected, but the steam machinery is now only for emergencies. No new steam engines have been installed since the electrical equipment was first started, except a steam turbo-generator to supplement the hydro-electric plant during low stages of water. The hydro-electric plant was described in a paper by T. W. Orbison and F. H. Armstrong in the Proceedings of 1908, Vol. XIII, page 177, and the machinery equipment of the mines is the subject of a paper by Mr. Armstrong which appears in another part of these Proceedings. No attempt has been made to tram with electric trolleys underground, as the ore is scattered between so many shafts and different levels that electric equipment for this purpose would not be justified.

William Kelly, Vulcan, Mich., is general manager of the properties operated by the Penn Iron Mining Company.

HOLLISTER MINE.

This is what may be called one of the re-claimed mining prospects of the Crystal Falls district. At present mining is being done at a depth of 750 feet through a two-compartment exploratory shaft six feet by ten feet inside. The hoist is a duplex Webster Camp and Lane, with six-foot drum. The air is supplied by a Hall compressor, capable of running seven drilling machines. The surface is equipped with shops, etc. At the present time experimenting is being done with a dryer, for the purpose of eliminating as much moisture from the ore as possible. This dryer has a capacity of 300 tons per day. Frank Scadden, of Crystal Falls is in charge of the property which is operated by M. A. Hanna & Co.

EXPLORATIONS.

The following is a list of explorations being carried on at the time of the Institute trip through the district:

The Republic Iron & Steel Co.—Operating two drills on the Sherwood, south of the James mine, section 23, 43-35.

Jones & Laughlin Co.—One drill west of the James, on section 15, 43-35.

Powers & Gary Exploring Co.—Operating one drill on the Aronson property, on section 23.

The Munroe Mining Co.—Operating one drill on the Minckler property, also on section 23.

The Iron River Ore Co.—Two drills on section 22, 43-35.

The Corrigan-McKinney Co.—Operating one drill on the Carlson property, east of the Baker mine, section 31, 43-34.

The Wickwire Steel Co.—Operating one drill on the Greig property, section 33, 43-35, one on the Purcell, section 14, 43-35, and one on the McDonald property, section 24, 43-35.

The Cleveland-Cliffs Iron Co.—Three drills in operation on sections 21, 22 and 23, 43-34.

The Oliver Iron Mining Co.—Operating one drill on section 25, 43-34, east of the Chicagoan mine.

The Blair & Gibbs Exploring Co.—Two drills in operation, one on section 35, 44-36; one on 35, 43-34, and a test-pit crew on section 3, 43-36.

The Michigan Mining Co.—Two exploratory shafts. Section 36, 43-35 and section 6, 42-34.

PRODUCING MINES OF IRON COUNTY.

Name of Mine.	Operator.	Location.	Manager.	Address.
Great Western	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Tobin	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Dunn	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Armenia	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Baker	Corrigan, McKinney & Co.	Stambaugh	W. J. Richards	Crystal Falls
Tully	Corrigan, McKinney & Co.	Stambaugh	W. J. Richards	Crystal Falls
Bristol	Ogleby, Norton & Co.	Crystal Falls	E. W. Hopkins	Commonwealth
McDonald	Huron Iron Mining Co.	Crystal Falls	G. W. Youngs	Iron River
Hollister	M. A. Hanna & Co.	Crystal Falls	Frank Scadden	Crystal Falls
Baltic	Verona Mining Co.	Palatka	C. E. Lawrence	Iron Mountain
Caspian	Verona Mining Co.	Palatka	C. E. Lawrence	Iron Mountain
Fogarty	Verona Mining Co.	Iron River	C. E. Lawrence	Iron Mountain
Hemlock	Verona Mining Co.	Amasa	C. E. Lawrence	Iron Mountain
Mansfield	Oliver Iron Mining Co.	Mansfield	O. C. Davidson	Iron Mountain
Michigan	Oliver Iron Mining Co.	Amasa	O. C. Davidson	Iron Mountain
Dober	Oliver Iron Mining Co.	Iron River	O. C. Davidson	Iron Mountain
James	Mineral Mining Co.	Iron River	E. F. Brown	Iron Mountain
Konwinzki	Mineral Mining Co.	Iron River	E. F. Brown	Iron Mountain
Chatham	Oglebay Norton & Co.	Iron River	E. W. Hopkins	Commonwealth
Berkshire	Oglebay Norton & Co.	Iron River	E. W. Hopkins	Commonwealth
Gibson	Rogers-Brown Ore Co.	Amasa	T. H. Martin	Amasa
Hiawatha	Munroe Mining Co.	Iron River	G. L. Woodworth	Iron River
Chicagoan Lake	Munroe Mining Co.	Iron River	G. L. Woodworth	Iron River
Zimmerman	Spring Valley Iron Co.	Iron River	O. P. Doty	Iron River
Bates	Bates Iron Co.	Iron River	Felix A. Vogel	Florence
Gleason	Davidson Ore Mining Co.	Iron River	R. Erickson	Iron River

IDLE MINES.

Name of Mine.	Operator.	Location.	Manager.	Address.
Lot 3	Wisconsin Steel Co.	Crystal Falls	Geo. Darlington	Crystal Falls
Crystal Falls	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Fairbanks	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Kimball	Corrigan, McKinney & Co.	Crystal Falls	W. J. Richards	Crystal Falls
Youngstown	Oliver Iron Mining Co.	Crystal Falls	O. C. Davidson	Iron Mountain
May	Oliver Iron Mining Co.	Crystal Falls	O. C. Davidson	Iron Mountain
Youngs	Huron Iron Mining Co.	Crystal Falls	G. W. Youngs	Iron River

PRODUCING MINES OF DICKINSON COUNTY.

Name of Mine.	Operator.	Location.	Manager.	Address.
Chapin	Oliver Iron Mining Co.	Iron Mountain	O. C. Davidson	Iron Mountain
Aragon	Oliver Iron Mining Co.	Norway	O. C. Davidson	Iron Mountain
Millie	Dessau Iron Co.	Iron Mountain	S. J. McGregor	Iron Mountain
Traders	Antoine Ore Co.	Iron Mountain	C. T. Fairbairn	Duluth
Pewabic	Pewabic Co.	Iron Mountain	E. F. Brown	Iron Mountain
Walpole	Pewabic Co.	Iron Mountain	E. F. Brown	Iron Mountain
Norway	Penn Iron Mining Co.	Norway	Wm. Kelly	Vulcan
Curry	Penn Iron Mining Co.	Norway	Wm. Kelly	Vulcan
Vulcan	Penn Iron Mining Co.	Vulcan	Wm. Kelly	Vulcan
Vivian	Verona Mining Co.	Quinnesec	C. E. Lawrence	Iron Mountain
Calumet	Verona Mining Co.	Calumet	C. E. Lawrence	Iron Mountain
Loretto	Loretto Iron Co.	Loretto	J. W. Amberg	Chicago
Munro	Munro Mining Co.	Norway	G. L. Woodworth	Iron River
Few	Few Mining Co.	Norway	E. C. Eastman	Marinette
Groveland	Groveland Mining Co.	Randville	G. W. Youngs	Iron River

IDLE MINES.

Name of Mine.	Operator.	Location.	Manager.	Address.
Cundy	Oliver Iron Mining Co.	Quinnesec	O. C. Davidson	Iron Mountain
Quinnesec	Corrigan, McKinney & Co.	Quinnesec	W. J. Richards	Crystal Falls
Saginaw	Saginaw Mining Co.	Norway	E. W. Jones	Iron Mountain
Breen	Mineral Mining Co.	Waucedah	E. F. Brown	Iron Mountain
Forest	Oliver Iron Mining Co.	Iron Mountain	O. C. Davidson	Iron Mountain
Cuff	Oliver Iron Mining Co.	Iron Mountain	O. C. Davidson	Iron Mountain

MENOMINEE RANGE MINES IN WISCONSIN.

Name of Mine.	Operator.	Location.	Manager.	Address.
Florence	Florence Iron Co.	Florence, Wis.	E. S. Dickenson, Supt	Florence, Wis.

MENOMINEE RANGE.

Iron Ore Shipments (Gross Tons) for 1910 and Total to Date.

Name of Mine.	1910.	Total to Date.
Alpha		1,370
Antoine (Clifford)	91,081	1,548,499
Aragon	241,046	6,077,327
Armenia	65,473	377,081
Baker	39,417	84,420
Baltic	171,930	1,340,593
Berkshire	97,999	135,734
Breen		75,425
Bristol (Claire)	270,742	2,456,109
Calumet		121,354
Chapin (Ludington)	465,543	17,649,477
Caspian	171,334	699,305
Chatham	51,988	181,427
Columbia		942,703
Commonwealth	89,116	2,600,900
Crystal Falls		1,735,251
Cuff		58,419
Cundy		721,321
Dober (Riverton)	84,269	2,195,146
Dunn	136,144	1,658,015
Eleanor (Appleton)		18,719
Fairbanks (P't. R.)		379,789
Florence	239,161	2,957,180
Fogarty	51,071	168,936
Forest		11,988
Genesee (Ethel)	66,185	537,624
Gibson	45,202	102,353
Great Western	80,709	1,952,937
Groveland	26,462	100,554
Hemlock	115,407	1,705,225
Hiawatha	128,884	614,496
Hilltop		20,229
Hollister	49,434	96,416
Hope		28,530
James	78,388	231,359
Keel Ridge		93,101
Kimball		16,224
Lamont (Monitor)	3,183	558,524
Lincoln		241,627
Loretto	116,048	1,311,068
Mansfield	114,357	1,217,355
McDonald	6,022	7,166
Michigan	17,922	171,719
Millie (Hewitt)		368,267
Monongahela		9,310
Munro	20,022	298,578
Nanaimo		373,765
Northwestern		35,810
Pennsylvania Iron Mining Co	344,760	8,845,135
Pewabic	380,376	7,317,165
Quinnesec	744	627,215
Saginaw (Perkins)		502,985
Sheridan		116,299
Tobin	235,812	1,630,549
Tully	2,726	2,726
Verona		130,975
Vivian	14,827	420,239
Youngs	98,399	473,784
Zimmerman	25,555	37,690
Miscellaneous		1,057,306
Total	4,237,738	75,450,793

[From Iron Trade Review]

LAKE SUPERIOR IRON ORE SHIPMENTS FROM THE DIFFERENT RANGES FOR 1905, 1906, 1907, 1908, 1909 AND 1910, AND GRAND TOTAL FROM 1855 TO 1910, INCLUSIVE.

(Compiled from Tonnage as Publ'shed by Iron Trade Review).

		1905.	1906.	1907.	1908.	1909.	1910.	Grand Tot.
Marquette Range......	(Tons....	4,210,522	4,057,187	4,388,073	2,414,632	4,256,172	4,392,726	96,309,304
	(Per cent	12.2	10.5	10.3	9.3	10.0	10.1	19.5
Menominee Range.....	(Tons....	4,495,451	5,109,088	4,964,728	2,679,156	4,875,385	4,237,738	75,433,492
	(Per cent	13.1	13.3	11.8	10.3	11.4	9.9	15.3
Vermilion Range.......	(Tons....	1,677,186	1,792,355	1,685,267	841,544	1,108,215	1,203,177	29,938,362
	(Per cent	4.9	4.7	4.	3.2	2.6	2.6	6.2
Gogebic Range.........	(Tons....	3,705,207	3,641,985	3,637,907	2,699,856	4,088,057	4,315,314	65,210,569
	(Per cent	10.8	9.4	8.6	10.4	9.5	10.0	13.3
Mesabi Range.........	(Tons....	20,153,699	23,792,882	27,492,949	17,257,350	28,176,281	29,201,760	224,870,949
	(Per cent	58.7	61.7	65.1	66.3	66.1	67.2	45.6
Miscellaneous	(Tons....	111,391	128,742	76,146	122,449	82,759	91,682	698,562
	(Per cent	.3	.4	.2	.5	.2	.2	.1
Total tons......		34,353,456	38,522,239	42,245,070	26,014,987	42,586,869	43,442,397	492,461,338
		Increase over 1904 57.4%	Increase over 1905 12.1%	Increase over 1906 9.8%	Decrease from 1907 38.5%	Increase over 1908 63.6%	Increase over 1909 2.0%	

THE SIXTEENTH ANNUAL MEETING.

TUESDAY, AUGUST 22, 1911.

The Westerly end of the Menominee Range has, during the past few years, shown perhaps greater extensions in ore bodies, particularly in the so-called Iron River District, than any other of the iron ranges in the Michigan field. Many new mines have been added to the list of producers and there is at the present time, much new exploratory work in progress. Diamond drilling and exploring shaft are found in new territory, some of which are very promising, while others have not progressed sufficiently to determine the ore measure. The State Geological Survey has given the Iron River District much attention and its work has been of great benefit to the explorer. The attendance at the meeting was assured, as the mining men have been following the progress of this district with interest. Large sums have been expended in the exploration and opening of new properties, which were to be visited during this meeting. The attendance numbered 250 members and guests.

The first stop made by the special train after lunch was at the Hollister, operated by M. A. Hanna & Co., Frank Scadden. Manager. Much interest was shown in the ore-dryer in operation at this mine. The plant is of an experimental kind, and is 6 by 35 feet in size, made by the Atlas Company of Cleveland, Ohio. The moisture is reduced from 15 per cent to 6 per cent and 150 tons per day is being treated. The next stop was at the Tobin Mine of Corrigan-McKinney & Company, of which W. J. Richards, President of the Institute, is General Manager. The Tobin is one of the largest mines in Iron County, is fully equipped and produced 235,812 tons in 1910. From here the party was taken by automobiles to "Idlewild," the beautiful summer home of W. J. Richards, on the shore of Fortune Lake. A barbecue was the feature, prepared by the Commercial Club of Crystal Falls.

EVENING SESSION.

At eight o'clock the members met at the Court House where the business session was held. The meeting was opened by W. J. Richards, President, who extended a most cordial welcome on behalf of the Citizens of the Menominee Range. Mr. Richards stated that it was most gratifying to their local committee to have such a large attendance, considering that a number of the mines were at present idle, owing to the dullness in the iron and steel market. He called attention to the development in the Western end of the Range and spoke with much encouragement of the future prospects of the district. Mr. Richards then introduced Charles H. Watson of Crystal Falls, who delivered the address of welcome. Mr. Watson spoke in part as follows:

Mr. President and Members of the Lake Superior Mining Institute:

The citizens of Crystal Falls appreciate in the fullest measure the high honor of being permitted to the best of their limited ability, to entertain this convention of men who, in a large measure, are furnishing the brawn and brain for the development and operation of the greatest mining region upon and in the surface of the globe. I have referred to the limitations under which my fellow citizens strive to this end, for it must be recognized that in a village of the size of our Crystal Falls, many limitations of necessity hamper the possibilities for the adequate accommodation and entertainment of a gathering of the proportions of the present meeting. We must ask you, therefore, to permit the breadth of our spirit of hospitality to compensate for any shortcomings along the line of our ability to demonstrate. We hope that during your visit to this part of the Menominee Range you will note that we have been contributing our fair share toward the development of this portion of the great Lake Superior basin. The very favorable conditions which have existed in the iron ore market during the years recently passed have induced capital to explore for and develop some of the iron ore bodies which in prior years had been considered worthless. An abandoned field of a few years ago, through these market conditions, the energy of our local mining men and the business daring of those whom they represent, has been turned into an active and productive district. The value of many of these properties, however, remains for the future to prove. We, who live beside some of these properties, for divers reasons have been inclined to doubt their ultimate value under anything but the most favorable conditions, and really have never appreciated how highly important we were in dollars and cents until very recent expert advices have been received from Lansing. Seriously, however, even these advices we fear will have to stand the test of time and experience.

Again, I desire to say, that we are under deep obligation to the Lake Superior Mining Institute. In the first place, we are indebted to you for having selected, last year, our well beloved fellow citizen, William John Richards, as your President. This feeling was demonstrated at that time by a sumptuous banquet which was tendered to Captain Richards to celebrate his election to the presidency of this important body. I want, at this time, on behalf of the citizens of Crystal Falls and Iron County, to personally thank you for this honor.

Stepping aside for the moment, from my capacity as a representative of the citizens of Crystal Falls, I think it should be considered a fitting tribute to those not at all connected with the mining industry or the Lake Superior Mining Institute, who have contributed so liberally to the preparation for this meeting, to say on behalf of your president and those of us who are members of the Mining Institute and connected with the mining industry, that we appreciate their efforts in this behalf in the highest measure.

It was the custom of the ancients when friendly hosts approached the gates of a city to cause the mayor or other executive head thereof to render up the keys to the city in token of the hospitality of the citizens toward the visitors. Something symbolical of this has been the custom from time immemorial. On behalf of the mayor and the citizens of Crystal Falls, at this time, however, it is my high privilege to say to you that we have no keys to deliver—the keys have been deposited in the deepest well within the city, the gates and doors have been unbarred and thrown wide open and in welcome to you we bid you enter and help yourselves.

The first paper of the evening was by A. M. Gow of Duluth, Minnesota, on "Some Safety Devices of the Oliver Iron Mining Company." In introducing this subject, Mr. Gow spoke as follows:

Mr. President and Gentlemen of the Institute: In the matter of Safety Devices, we, in this country are about fifty years behind time. The Steel Corporation woke up to this fact several years ago and since that time, the General Safety Committee has been waking up the subsidary Companies. This General Committee consists of ten men and appoints all the sub-committees which visit the various works and mines of the Corporation to make recommendations and point out where conditions can be improved. There have been in the neighborhood of seven thousand recommendations made by the examining committee, looking to safety plans and over 90 per cent of these recommendations have been accepted without any question. It is not to be expected that safety devices will prevent accidents altogether. Accidents will happen around a mine, even with the best protection to safeguard the men. I don't think you care to have me make any extended remarks on the rules and devices which have been put in, so I will show in a few pictures some of the plans and devices which have been put into effect for the safety of our employes.

Mr. Gow's further remarks were in explanation of the various devices for shops, mills and mines, which were displayed by stereopticon views, and were followed with close attention by the members. A more detailed description accompanies the views selected for publication.

The next paper for the evening was by C. E. Lawrence of Iron Mountain, Michigan, on "Social Surroundings of the Mine Employe." This is a subject which is receiving very careful attention by mine managers in this section, and Mr. Lawrence has followed closely the results of the efforts of Pickands, Mather & Company, with which firm he is engaged as Superintendent of their Menominee Range properties. This concluded the reading of papers for this session.

On motion, the President appointed the following Committees, the same to report at the next session:

COMMITTEE ON NOMINATIONS—W. H. Johnston, Ishpeming, Mich.; W. H. Jobe, Palatka, Mich.; Graham Pope, Houghton, Mich.; D. E. Sutherland, Ironwood, Mich.; J. D. Ireland, Duluth, Minn.

AUDITING COMMITTEE—J. B. Cooper, Hubbell, Mich.; C. E. Lawrence, Iron Mountain, Mich.; W. J. West, Hibbing, Minn.

WEDNESDAY, AUGUST 23RD.

Promptly at nine o'clock the party was conveyed by two special trains from Crystal Falls to the Iron River-Stambaugh district, stopping at the Baltic mine of Pickands, Mather & Co., which is briefly described on page 32. The Club house, erected and maintained for the benefit of the employes of this company, was inspected. The building is complete in its equipment for a social club and is much enjoyed by the employes. It is well patronized and has proven very successful, as it has attracted a desirable class of miners to the immediate locality. The village of Palatka, where the club is located, contains many attractive buildings and the grounds and streets present an appearance of neatness.

The Youngs and Caspian mines were next visited, after which the party returned to Iron River where the James mine of the Mineral Mining Co. was inspected. This is a new property and is being equipped with substantial buildings and a steel head frame. Returning to Iron River, where luncheon was served on the trains, the members later met at the Opera House where a business session was held at 2 o'clock.

The first paper presented was on the "Block Caving and Sub-Stoping System at the Tobin Mine." This paper, prepared by Fred C. Roberts, was read by Professor Sperr of the Michigan College of Mines. This was followed by a paper on "Top Slicing and Caving Systems in the Stambaugh District," by W. A. MacEachern, of Iron River, Mich. E. E. White of Ishpeming, Mich., read a paper on "Surveying and Sampling Diamond Drill Holes," which was illustrated by drawings showing curvatures in drill holes. The last paper was by T. B. Wyman of Munising, Mich., Secretary-Forester of the Northern Forest Protective Association, the title being "The Relation of Mining Interests to the Prevention of Forest Fires." Mr Wyman presented important facts in connection with the supply of timber available for mining and strongly urged the necessity of reforestation.

The following papers were read by title:

Accidents in the Transportation, Storage and Use of Explosives, by Charles S. Hurter, Duluth, Minn.

Square Set Mining, by Floyd L. Burr, Vulcan, Mich.

Check System of Time Keeping, by James D. Vivian, Crystal Falls, Mich.

Boiler Setting and Coal Handling, by J. S. Jacka, Crystal Falls, Mich.

Electrical Operating Plants of Penn Iron Mining Company, by Frank H. Armstrong, Vulcan, Mich.

A Diamond Drill Core Section of the Mesabi Rocks—No. IV., by N. H. Winchell, Minneapolis, Minn.

Some Practical Suggestions for Diamond Drill Explorations, by A. H. Meuche, Houghton, Mich.

Recording and Signalling Device for Mines, by John M. Johnson, Ishpeming, Mich.

Time Keeping System and Labor Distribution at the Newport Mine, by G. L. Olson, Ironwood, Mich.

Raising Shaft on Timber at the Armenia Mine, by S. J. Goodney, Crystal Falls, Mich.

Cornwall Ore Banks of Lebanon County, Pennsylvania, by E. B. Wilson, Scranton, Pa.

At the conclusion of the reading of papers, the Council presented its report for the fiscal year ending August 22, 1911.

REPORT OF THE COUNCIL.

The Secretary's report of Receipts and Expenditures from August 26th, 1910, to August 22nd, 1911, is as follows:

RECEIPTS.

Cash on hand August 24th, 1910........			$5,076.55
Entrance fees for 1910..................$	215.00		
Dues for 1910	2,025.00		
Back dues	180.00		
Advance dues, 1911	65.00		
Sale of proceedings	57.30		
Sale of Institute badges................	8.00		
Total		$2,550.30	
Interest on deposit		171.24	
Total receipts			2,721.54
Grand total			$7,798.09

DISBURSEMENTS.

Stationery and printing ....$	58.85		
Postage	139.16		
Freight and express	13.81		
Telephone and telegraphing.............	3.91		
Secretary's salary	750.00		
Stenographic work	82.44		
Total		$1,048.17	
Publishing Proceedings XV.............$	732.50		
Photographs, maps, etc.................	57.50		
Advance papers, 1910	188.75		
Total		978.75	
Total disbursements			2,026.92
Cash on hand August 19, 1911...........			5,771.17
Grand total			$7,798.09

MEMBERSHIP.

	1911.	1910.	1909.
Members in good standing....................	467	465	475
Honorary members	4	4	4
Life members	2	2	2
Members in arrears (2 years, '09-'10)...........	44	36	36
Total	517	507	517
New members admitted	46	45	72
New members not qualified..................	3	1	1
New members added	43	44	71

TREASURER'S REPORT.

The Treasurer's report from August 26th, 1910, to August 22d, 1911, is as follows:

Cash on hand August 26th, 1910..................	$5,076.55	
Received from Secretary.........................	2,550.30	
Interest on deposits	171.24	
Paid drafts issued by Secretary..................		$2,026.92
Cash on hand August 22d, 1911..................		5,771.17
	$7,798.09	$7,798.09

Your committee appointed to examine the books of the Secretary and Treasurer, beg leave to report that we have carefully examined same and find that the receipts and expenditures shown therein to be in accordance with the above statement for the fiscal year ending August 22nd, 1911.

JAMES B. COOPER,
WILLIAM J. WEST.
CHAS. E. LAWRENCE.

The following applications for membership, received since the last annual meeting, are approved by the Council:

Boss, Clarence M., Mining Engineer, Duluth, Minn.

Bowers, E. C., Secretary Wickwire Mining Co., Iron River, Mich.

Burnham, R., Commercial Salesman, Westinghouse Mfg. Co., Minneapolis, Minn.

Cory, Edwin N., Mining Captain, Negaunee, Mich.

Deacon, John, Superintendent, Cambria and Lilly Mines, Negaunee, Mich.

Fox, M. J., Lumberman, Iron Mountain, Mich.

Gish, John R., Commercial Salesman, Beaver Dam, Wis.

Goodney, S. J., Mining Captain, Crystal Falls, Mich.

Hampton, H. C., Salesman, Chicago, Ills.

Hovland, Joseph T., Mining Engineer and Drill Contractor, Houghton, Mich.

Huhtala, John, Superintendent, Richmond Mine, Palmer, Mich.

Imhoff, Wallace G., Geological Engineer, Y. M. C. A., Ishpeming, Mich.

Jacka, Edwin, Mining Captain, Armenia Mine, Crystal Falls, Mich.

McDonald, James A., Salesman, Advance Packing & Supply Co., Hancock, Mich.

Morgan, E. Robins, Resident Engineer, Robins Conveying Belt Co., Chicago, Ills.

Myers, Albert J., Mining Engineer, Iron Mountain, Mich.

Newby, Wm., Assistant Mining Captain, Puritan Mine, Ironwood, Mich.

Pengilly, Ed., Mining Captain, Crystal Falls, Mich.

Rowe, Wm. C., Mining Captain, Bessemer, Mich.

Ryan, John A., Chief Clerk, O. I. M. Co., Iron Mountain, Mich.

Trevarthan, W. J., Mining Captain, Bessemer, Mich.

Trudgeon, John, Mining Captain, Wakefield, Mich.

Uhler, Fred Walter, Mining Engineer, Buhl, Minn.

Vilas, Royal L., Sales Manager, Pluto Powder Co., Ishpeming, Mich.

Vivian, David L., Mill Superintendent, Gay, Mich.

Walker, Robert L., Superintendent, American Mine, Diorite, Mich.

Warne, Edw. S., Mill Superintendent, Point Mills, Mich.

Wheelwright, O. W., Geologist, Florence Iron Co., Florence, Wis.

Worden, E. P., Chief Engineer, F. M. Prescott Steam Pump Co., Milwaukee, Wis.

Yates, William H., Sales Engineer, Allis-Chalmers Co., Negaunee, Mich.

Zapffe, Carl, Mining Geologist, Brainerd, Minn.

On motion duly carried the report of the Council was accepted and the Secretary instructed to cast a ballot for the election of the applicants to membership.

The committee on nominations presented its report as follows:

Your committee on nominations beg leave to submit the following names for officers of the Institute for terms specified:

For President (one year):
Frederick W. Denton, Painesdale, Mich.

For Vice Presidents (two years):
George H. Abeel, Ironwood, Mich.
Graham Pope, Houghton, Mich.
Wm. H. Jobe, Palatka, Mich.

For Managers (two years):
M. H. Godfrey, Coleraine, Minn.
Jas. E. Jopling, Ishpeming, Mich.

For Treasurer (one year):
E. W. Hopkins, Commonwealth, Wis.

For Secretary (one year):
A. J. Yungbluth, Ishpeming, Mich.

W. H. JOHNSTON,
D. E. SUTHERLAND,
JAMES D. IRELAND,
WILLIAM H. JOBE,
Committee.

The report of the committee was on motion adopted and the Secretary instructed to cast a ballot for the election of the officers as presented by the committee.

William Kelly, of Vulcan, Mich., offered the following resolution, which was on motion adopted:

Resolved, That the Council be authorized to appoint from time to time special committees to consider and report upon to the Institute through the council such subjects as changes in mining laws, safety devices, the securing and editing of papers on mining methods, definition of mining terms, affiliations with other societies, and such other subjects as the Council shall deem it desirable to inquire into, such reports not to be binding on the Institute except action is taken by the Institute in accordance with the Constitution and By-Laws.

John M. Bush, of Ironwood, Mich., offered the following resolution, which was on motion adopted:

Resolved, That a vote of thanks be extended to the Mining Companies of the Menominee Range and their local officials for the entertainment offered on the occasion of this visit; also to the citizens of the range as a whole for their cordial reception; to the Railway Companies for the exceedingly good service given in the movement of the members in special trains and the many courtesies and privileges shown our members and guests.

MR. KELLY—I would like to say a word before we adjourn. There has been some consideration by the governing body of the American Institute of Mining Engineers to extend the scope of its influence, and it is possible that some plan for affiliation with the Lake Superior Mining Institute and other similar organizations may be suggested. I would not advocate any proposition that would result in giving up the automatic existence of this Institute, but still it is possible that our publications could obtain a wider circulation if they were incorporated with the publication of the American Institute of Mining Engineers. We have the President of the American Institute of Mining Engineers with us and as it will only take up two or three minutes' time, and you may be willing to hear something on that subject, I ask the privilege of the floor for Mr. Kirchhoff.

MR. KIRCHHOFF—This is an era of co-operation and team work and we have been much encouraged in seeing how it has developed in engineering fields in recent years. We are now installed in a building, through the munificence of Mr. Carnegie, which represents a cost of about $1,800,000. Mr. Carnegie gave us $1,050,000 of this amount. Since the erection of this building, we have been able to bring together the different branches of engineering into co-operation and good-fellowship. We now have a library of some 50,000 volumes which has grown out of the collections of the Mechanical Engineers, the Electrical Engineers and the Mining Engineers. It is now under the management of an expert librarian and an adequate staff, thus realizing to an extent, hitherto impossible, the benefits of co-operation.

I have been very much struck by the proposal just made before the meeting to unify mining nomenclature, and in behalf of the Institute offer you our cordial co-operation in the work, in which no doubt such organizations as the Canadian Mining Institute, the Mining and Metallurgical Society, the Institute of Mining and Metallurgy, the South African Society and others would probably gladly join. It is through co-operation along such lines that much good can be accomplished.

Upon the conclusion of the business session, the members and guests were taken by automobiles to Sunset Lake, where the Iron River Commercial Club had prepared a clambake and other entertainment for the visitors. An orchestra furnished music during the evening and an enjoyable time was had by all.

THURSDAY, AUGUST 24TH.

Promptly at eight o'clock in the morning the party left Iron River, arriving at Loretto at ten, where the Loretto mine was visited. A trip was made up to the dam which was constructed when the course of the Sturgeon river was changed, and the new channel was followed to the point where it again took the original course. The changing of the river was made necessary as it crossed directly over the ore formation, making it impossible to remove the ore with safety even by leaving large pillars to support the surface. A brief description with map is published elsewhere in this volume.

The party next visited the dam and power plant of the

Penn Iron Mining Co. at Sturgeon falls on the Menominee river. Seventy automobiles were brought into service and the four-mile trip was made in quick time. This plant is fully described in Vol. XIII, 1908, page 153. The next stop was at the Company's mines at Vulcan where the East and West Vulcan and Brier Hill Shafts were visited, also the Aragon mine of the Oliver Iron Mining Co. at Norway. The electrically-driven machinery at the Penn Iron Co.'s mines was very carefully inspected, being the first plant of its kind in the district, and considerable time was spent here.

Many of the visitors took the opportunity of going down in the Vulcan shaft to see the electrically-driven pumps, provision having been made by enclosing the cage so that the trip could be made without the necessity of special clothing. The route to be taken in inspecting the surface plant was indicated by arrows placed at various points which avoided confusion and kept the crowd from scattering. Guides accompanied the party giving such information as was desired by the visitors.

Continuing the trip by automobiles to Iron Mountain, the new plant of the Peninsular Power & Development Co, under construction at Twin Falls on the Menominee river, was next visited. This plant will develop 5,000 horsepower, ample to supply all the mines in the vicinity. It is expected that the work will be completed during the summer of 1912. Returning to Iron Mountain, the Ludington shaft of the Oliver Iron Mining Co. was the next stop. The Cornish pumping plant which was formerly installed at "D" shaft of the Chapin is now in operation at "C" Ludington. A visit was also made to the Pewabic mine, after which the party disbanded.

A brief description of the mines visited, also many of the others, in both Iron and Dickinson counties, may be found on pages 17 to 40.

The beautiful roads on the Menominee Range, especially through Dickinson county, where the country is more level than in Iron county, made the automobile trips a very interesting and enjoyable feature throughout. Special trains, in addition to the regular, were provided where necessary to take the members home with the least possible delay. Congratulations were freely extended to the local committees for the admirable manner in which the arrangements were carried out, and the meeting proved both profitable and enjoyable. Credit is also due to the members for their generous response with papers on many interesting subjects.

The following is a partial list of those in attendance:

ABEEL, GEO. H....................Hurley, Wis.
ADGATE, F. W....................Chicago, Ills.
ALLEN, R. C....................Lansing, Mich.
AMBERG, J. W....................Chicago, Ills.
ARCHIBALD, R. S....................Crystal Falls, Mich.
ARMSTRONG, F. H....................Vulcan, Mich.

BACON, F. A....................Princeton, Mich.
BARBER, G. S....................Bessemer, Mich.
BAXTER, C. H....................Loretto, Mich.
BENGRY, W. H....................Palatka, Mich.
BERTLING, J. F....................Chicago, Ills.
BJORK, ARVID ....Crystal Falls, Mich.
BOND, WILLIAM ....Iron River, Mich.
BOSS, C. M....................Duluth, Minn.
BOYLE, O. F....................Crystal Falls, Mich.
BREWSTER, E. E....................Iron Mountain, Mich.
BREWER, L. C....................Ironwood, Mich.
BRIDGES, E. S....................Crystal Falls, Mich.
BRIGHAM, E. D....................Chicago, Ills.
BROOKS, F. G....................Stambaugh, Mich.
BROWN, E. F....................Iron Mountain, Mich.
BURNHAM, R....................Minneapolis, Minn.
BURNS, A. L....................Crystal Falls, Mich.
BUSH, J. M....................Ironwood, Mich.

CARBIS, FRANK ....Iron Mountain, Mich.
CARBIS, W. J....................Iron Mountain, Mich.
CARLSON, WM....................Crystal Falls, Mich.
CARPENTER, A. B....................Los Angeles, Cal.
CASWELL, L. C....................Crystal Falls, Mich.
CHAMPION, JOHN ....Loretto, Mich.
CLIFFORD, J. M....................Escanaba, Mich.
COE, E. S....................Iron River, Mich.
COLE, W. T....................Ishpeming, Mich.

CONLIN, THOMAS ....Crystal Falls, Mich
CONOVER, A. B..........................Chicago, Ills.
COOPER, J. B..........................Hubbell, Mich.
CORIA, J. W............................Ashland, Wis.

DAVIDSON, C. J.......................Milwaukee, Wis.
DAVIDSON, D. W.................Iron Mountain, Mich.
DAVIDSON, O. C.................Iron Mountain, Mich.
DAVIDSON, W. F....................Crystal Falls, Mich.
DAVIS, J. M..........................Green Bay, Wis.
DEACON, J ....Negaunee, Mich.
DICKENSON, E. S.......................Florence, Wis.
DIXON, F. A.........................Stambaugh, Mich.
DUNCAN, M. M.......................Ishpeming, Mich.
DUPRES, NAPOLEON ....Stambaugh, Mich.

EDWARDS, J. P.......................Mansfield, Mich.
EISELE, L. G.....................Iron Mountain, Mich.
EISELE, G. J.....................Iron Mountain, Mich.
ELDRIDGE P. C.......................Milwaukee, Wis.
ERICSON, JOHN ....Crystal Falls, Mich.
ERICSON, RUDOLPH ....Iron River, Mich.
ESTEP, H. COLE.........................Chicago, Ills.

FISHWICK, E. G.......................Milwaukee, Wis.
FLANCHER, F. A...................Crystal Falls, Mich.
FLODIN, N. P..........................Marquette, Mich.
FLOOD, J. R.......................Crystal Falls, Mich.
FRASER, W. H...................Crystal Falls, Mich.

GISH, J. R..........................Beaver Dam, Wis.
GODFREY, M. H.......................Coleraine, Minn.
GOLDSWORTHY, M...............Iron Mountain, Mich.
GOODNEY S. J.....................Crystal Falls, Mich.
GOODSELL, B. W........................Chicago, Ills.
GORDY SHEPARD B......................Derby, Conn.
GOUDIE, JAMES, JR...................Ironwood, Mich.

HAMPTON H. C.........................Chicago, Ills.
HANSON, W. J..........................Palatka, Mich.
HARDENBURG, L. M.....................Hurley, Wis.
HASTINGS E.........................Green Bay, Wis.
HEARLEY M. T........................Cleveland, Ohio
HEGGATON, WM. S...................Negaunee, Mich.
HELMER, C..........................Escanaba, Mich.
HELMER, W. S.......................Escanaba, Mich.
HICKS, B. W............................Vulcan, Mich.
HILL, W. D.........................Crystal Falls, Mich.
HINE, S. K..............................Girard, Ohio
HODGSON, JOSEPH ....Ishpeming, Mich.

HOLMAN, J. WINCHESTER ....Chicago, Ills.
HOLMES, HERMAN ....Crystal Falls, Mich.
HOPKINS, E. W....................Commonwealth, Wis.
HOVLAND, J. T........................Houghton, Mich.
HUEY, GEO. T.......................Minneapolis, Minn.
HUHTALA, JOHN ....Negaunee, Mich.
HURTER, CHAS. S........................Duluth, Minn.

IMHOFF, W ....Ishpeming, Mich.
IRELAND, J. D............................Duluth, Minn.

JACKA, E ....Crystal Falls, Mich.
JACKA, J. S.........................Crystal Falls, Mich.
JACKSON, I. H.......................Crystal Falls, Mich.
JACOBS, SAM ....Crystal Falls, Mich.
JAYNE, WM.. ....Crystal Falls, Mich.
JEWELL, SAMUEL ....Ishpeming, Mich.
JOBE, W. H..............................Palatka, Mich.
JOHNSON, O. R......................Michigamme, Mich.
JOHNSON, J. M.......................Ishpeming, Mich.
JOHNSTONE, O. W....................Ironwood, Mich.
JOHNSTON, W. H.....................Ishpeming, Mich.
JONES, JOHN T..................Iron Mountain, Mich.
JORY, WM.. ....Princeton, Mich.

KEATING, W. G........................Escanaba, Mich.
KEELEY, E. D............................Chicago, Ills.
KELLY, WILLIAM ....Vulcan, Mich.
KENNEDY, J. S..........................Ashland, Wis.
KERN, WM.. ....Crystal Falls, Mich.
KIRCHOFF, CHARLES ....New York
KITTS, T. J...........................Houghton, Mich.
KLINGLUND, F. D...................Iron River, Mich.
KONWINSKIN, JOE ....Iron River, Mich.
KRETZ, W. C.............................Trenton, N. J.
KROGDAHL, S. J......................Ishpeming, Mich.
LARSON, C. F......................Crystal Falls, Mich.
LAWRENCE, CHAS. E.............Iron Mountain, Mich.
LETZ, J. F............................Milwaukee, Wis.
LINSLEY, W. B........................Escanaba, Mich.
LUKEY, FRANK ....Ironwood, Mich.
LUNDIN, OLE ....Stambaugh, Mich.

MACE, R. E.............................Duluth, Minn.
MATTHEWS, A. ....Crystal Falls, Mich.
MEAD, D. W............................Madison, Wis.
MEUCHE, A. H........................Houghton, Mich.
MEYERS, W. R........................Princeton, Mich.
MINER, A. B.........................Ishpeming, Mich.

MITCHELL, W. A. . . . . Chicago, Ills.
MONROE, J. A. . . . . Iron River, Mich.
MORGAN, E. R. . . . . Chicago, Ills.
MORRISON, M. B. . . . . Stambaugh, Mich.
MYERS, A. J. . . . . Iron Mountain, Mich.
M'BERNEY WM. . . . . Stambaugh, Minn.
M'DONALD D. B. . . . . Duluth, Minn.
M'GEE, M. B. . . . . Crystal Falls Mich.
M'GONAGLE, W. A. . . . . Duluth, Minn.
M'GREGOR, S. J. Iron Mountain, Mich.
M'GREGOR, J. P. . . . . Milwaukee, Wis.
M'LEAN, J. H. . . . . Duluth, Minn.
M'LEAN, J. H., JR. . . . . Duluth, Minn.
M'NAMARA, THOS. B. Ironwood, Mich.
M'NEIL, E. D. . . . . Virginia, Minn.

NEELY, BENJAMIN . . . . Crystal Falls, Mich.
NETTLE, J H . . . . Stambaugh, Mich.
NEUGERLAUER, C. . . . . Crystal Falls, Mich.
NEWBY, WM . . . . Puritan, Minn.
NEWETT, WILLIAM . . . . Ishpeming, Mich

O'BRIEN, P. . . . . Iron River, Mich.
ORR, F. D. . . . . Duluth, Minn.
OSWALD, E. J. . . . . Crystal Falls, Mich.

PARKER, E. W. . . . . Washington, D. C.
PASCOE, P. W. . . . . Republic, Mich.
PEARCE, E. L. . . . . Marquette, Mich.
PENGILLY, E. . . . . Crystal Falls, Mich.
PENGLASE, THOMAS . . . . Crystal Falls, Mich.
PHILLIPS, W. G. . . . . Calumet, Mich.
POPE, GRAHAM . . . . Houghton, Mich.
POTTER, E. F. . . . . Minneapolis, Minn.

QUIGLEY, G. J. . . . . Antigo, Wis.
QUINE, J. T. . . . . Ishpeming, Mich.

RAISKY, F. H. . . . . Ishpeming, Mich.
RALEY, R. J. . . . . Duluth, Minn.
REEDER, E. C. . . . . Chicago, Ills.
REIGART, J. R. . . . . Princeton, Mich.
REYNOLDS, W. J. Crystal Falls, Mich.
RICHARDS, W. J. Painesdale, Mich.
RICHARDS, W. J. Crystal Falls, Mich.
RICHARDS, W. A. . . . . Chicago, Ills.
RICHARDS, ALVIN . . . . Chicago, Ills.
ROBERTS, H. C. . . . . Crystal Falls, Mich.
ROBERTS, E. S. . . . . Iron River, Mich.
ROBERTS, FRED C. . . . . Crystal Falls, Mich.

ROBERTSON, H. J......................Escanaba, Mich
ROGERS, C. M......................Crystal Falls, Mich.
ROSE, WM. T........................ Ishpeming, Mich.
ROSS, D. M........................Crystal Falls, Mich.
ROUGH, J. H..........................Negaunee, Mich.
ROWE, W. C..........................Bessemer, Mich.
RUNDLE, A. J...................Iron Mountain, Mich.
RYAN, J. A.......................Iron Mountain, Mich.

SAMPSON, JOHN ....Ashland, Wis.
SANDS, T. E........................ Minneapolis, Minn.
SCADDEN, FRANK ....Crystal Falls, Mich.
SCANLON, W. L.......................Iron River, Mich.
SCHIEBLER, W.......................Iron River, Mich.
SHAW, PHILLIP ....Crystal Falls, Mich.
SHERRERD, J. M............................New York
SHOVE, B. W..........................Ironwood, Mich.
SILLIMAN, A. P........................Hibbing, Minn.
SKINNER, M. B..........................Chicago, Ills.
SPEAR, J. H..........................Ironwood, Mich.
SPERR, F. W..........................Houghton, Mich.
STEWART, H. E......................Houghton, Mich.
STOLLBERG, J. R.................Crystal Falls, Mich.
SUTHERLAND, D. E...................Ironwood, Mich.

TALLON, P. M........................Milwaukee, Wis.
TARR, S. W.............................Duluth, Minn.
THOMPSON, N. W........................Albany, N. Y.
THOMPSON, N. W., JR..................Albany, N. Y.
TRAVER, W. H...........................Chicago, Ills.
TREBILCOCK, JOHN .... Ishpeming, Mich.
TREBILCOCK, WILLIAM ....North Freedom, Wis.
TREPANIER, H ....Iron Mountain, Mich.
TREVARROW, H.. ....Negaunee, Mich.
TREVARTHEN, W. J...................Bessemer, Mich.
TREZONA, CHAS ....Ely, Minn.
TRUDGEON JOHN ....Whitefield, Minn.
TUFTS, JOHN ....Milwaukee, Wis.
TUPPER, C. A........................Milwaukee, Wis.
TYLER, W. E............................Mendota, Ills.
TYLER, E. S........................Stambaugh, Mich.

VILAS, R. L..........................Ishpeming, Mich.
VILAS, P. N........................Minneapolis, Minn.
VIVIAN, JAMES D..................Crystal Falls, Mich.

WALKER, R. S...........................Diorite, Mich.
WALL, JOHN ....Crystal Falls, Mich.
WALL, J. S..........................Iron River, Mich.

WATSON, CHAS. H..................Crystal Falls, Mich.
WEBB, R. B........................Crystal Falls, Mich.
WEBB, CHAS. E......................Houghton, Mich.
WEBB, G. S..........................Marquette, Mich.
WELKER, W. F..........................Ashland, Wis.
WENGLER, M. B.......................Milwaukee, Wis.
WESSINGER, W. E......................Duluth, Minn.
WESSINGER, H. J........................Duluth, Minn.
WEST, W. J.............................Hibbing, Minn.
WHEELWRIGHT, O. W..................Florence, Wis.
WHITE, E. E..........................Ishpeming, Mich.
WHITING, LOWE ....Crystal Falls, Mich.
WILLIAMS, P. S........................Ramsay, Mich.
WILSON, E. B ....Scranton, Pa.
WINCHELL, W. H....................Minneapolis, Minn.
WINSLOW, FRANCIS ....Washington, D. C.
WORDEN, E. P........................Milwaukee, Wis.
WYLD, R. H..............................Chicago, Ills.
WYMAN, T. B..........................Munising, Mich.

YATES, W. H.........................Negaunee, Mich.
YUNGBLUTH, A. J....................Ishpeming, Mich.
YUNGBLUTH, ROY O.................Ishpeming, Mich.
YOUNGS, G. W.......................Iron River, Mich.
YOUNGS, F. W.......................Iron River, Mich.

A DIAMOND DRILL CORE SECTION OF THE MESABI ROCKS—IV.

BY N. H. WINCHELL, MINNEAPOLIS.

GEOLOGICAL BEARING OF THE FOREGOING DESCRIBED FACTS.

In the Proceedings of the Institute for three previous years (1908, 1909 and 1910) the writer has presented evidence to show that in Minnesota volcanic igneous rock composes a large proportion of the strata usually termed "Animikie," which also specifically may be designated *Mesabi.* These results seem to call for a discussion of the bearing which they present on the geological history of the rocks themselves and of the adjacent terranes.

Near the close of the Minnesota Geological Survey (i. e. in 1899) some evidence of this nature of the iron-bearing rocks of the Mesabi range was met with, and it was presented in the final report (Vol. V), where its purport was fully set forth. It was suggested that if a careful examination were to be made of the rocks of the Animikie, it might be found that detritus from igneous rocks was an important element in their composition. Reviewing what he wrote twelve years ago as to the igneous nature of the rock from which the Mesabi ore is derived, the writer is gratified and entirely satisfied with the conclusions to which he came, and desires to re-affirm them and strengthen them, with the new evidence already presented to the Institute.

It was a great surprise, however, to the writer to find so much igneous material in the Mesabi section, extending through a thickness amounting to more than two thousand feet. Throughout that thickness the eruptive material amounts to more than fifty per cent of the whole, at least in the region of present active mining.

Through the kind co-operation of Mr. E. J. Longyear, the writer was furnished with a series of nine drill-core samples taken from S. E. ¼ Sec. 30, T. 58-20, near Hibbing. These also were mounted in thin section by E. Dominique, Paris, and on examination were found to be so similar to those already described that, while they verify the record of the deeper drill, they afford no important new facts, from a microscopical point of view. They are from a point about thirty-three miles west from the other drill hole.

It is the present purpose to consider some of the consequences of this discovery, for it certainly changes very materially the interpretation which we must put upon the rocks of the Mesabi range. We do not know yet whether the igneous composition of the Animikie prevails throughout the full extent of those rocks, from east to west. We know of it at the eastern end of the range in Minnesota and in the productive western part, and at the point where it strikes the Mississippi. There is, however, an anomalous condition of the geology extending through Lake county and entering somewhat into St. Louis county, and prevailing south of the international boundary in Cook county. Here the geographic area in which the so-called "slates and quartzytes" of the Animikie would be expected to show their full extent and characteristics, is occupied by a group of rocks which are decidedly and distinctly of igneous origin. They are gabbro, and acid "red rock," so-called. The former grades into diabase, and thence into ordinary trap, petrographically. The latter is sometimes granitic, and sometimes is quartz porphyry. It also acted in large areas as an effusive igneous rock and flowed toward the basin of lake Superior in a manner the same as that which characterized the basic trap of the region. The writer has observed and has described numerous instances in which the "red rock" was plainly derived from the slate of the Animikie by contact metamorphism and fusion, apparently by the diabases and gabbro of the region. W. S. Bayley has shown the same on Pigeon point. Now this observation shows two things conclusively:

1. The slates were formed before they were metamorphosed and fused.

2. The metamorphosing agent was co-extensive with the metamorphism and fusion.

If, therefore, the great agent of this metamorphism and fusion was the gabbro and its derivatives, there must have been a long period of volcanic activity earlier than the gabbro outbreak, i. e. assuming that the Animikie in Lake and Cook counties possessed essentially the same volcanic composition as found in St. Louis county and near Gunflint lake, of which there is no known reason to entertain any doubt. The "red rock" is known to extend, with interruptions, from Pigeon point to Duluth. The gabbro does the same. It appears plain, therefore, that the gabbro was not the first, nor among the first of the basic eruptives to make its appearance but that probably it was nearer the close than the beginning of the Keweenawan age. It is also plain that the epoch of the Animikie, consisting, as shown, largely of basic igneous materials, formed as such before the gabbro, was a great igneous age, characterized by volcanoes and probably by surface lavas. The gabbro, and its product, the "red rock" were much later than this volcanic age.

The writer has heretofore shown reason to divide the Keweenawan into two parts, viz: The *Cabotian,* the older, and the *Manitou,* the younger, and he placed the gabbro and the "red rock" in the earlier member; but it appears to be necessary to remove them to the later. The Cabotian was an age during which were accumulated enormous quantities of volcanic sand and other debris, forming, as it appears, the Mesabi portion of the Animikie, as now known, and doubtless embracing many layers of surface trap. After these strata were laid down, mainly in the presence of oceanic waters, which contributed an acid, sedimentary element, they suffered the action of the great gabbro attack and this was accomplished and followed by other surface lavas.

While removing the gabbro and the "red rock" to the

Manitou section, it is necessary to note carefully an important distinction, viz: the materials which when fused, produced the Manitou red rock, prior to fusion constituted the Animikie slates, and, as seems to be reasonable in the light of recent developments, are to be considered the chronological equivalent of that part of the Keweenawan which has been named *Cabotian.* Basic, at first, having the form of volcanic ejecta, when mingled with the acid ingredients which it received by immersion and distribution in the waters of the ocean, it becomes frequently an acid rock when fused, forming the widespread "red rock" with all its variations, and as such it takes its place in the Manitou member of the Keweenawan.

It seems, from some points of view, a violent suggestion to associate the Animikie (Mesabi) with the Keweenawan, tor it brings into a later age those strata which have by some been put into the "upper Huronian" and by some into the Archean because (ignoring the Taconic) they lie in places non-comformably below what is by them believed to be the sole representative of the "Cambrian." But in reality such an adjustment of the new facts satisfies not only a reasonable demand of petrologic resemblances, but also of stratigraphic association. The petrologic resemblance between the Keweenawan and the Mesabi rocks has been the burden of my later papers. It is imperative, in considering the stratigraphic association, to call to mind the duplicate structure of the Keweenawan, as described in the final report of the Minnesota survey; for either the Keweenawan consists of two great members, as there described, or there exists a distinct, and separate, great igneous formation not hitherto discovered—one which has the thickness of over two thousand feet and which must have required for its sedimentary accumulation a great length of time, and which is by all geologists, who have studied the Keweenawan of Lake Superior, considered to be immediately below the well-known traps of the well-known Keweenawan. To link the Mesabi with the Keweenawan stratigraphically alleviates another anomaly, which the writer has elsewhere alluded to, viz: The top of the Animikie, as hitherto defined, has never been observed, although its highest strata, where locally exposed, as at Thunder Bay, have been seen to be overlain by a conglomerate of the "Upper Cambrian," there having been some kind of a break, and accompanying degradation of the Animikie, separating them. But if the Animikie (Mesabi) be only the downward extension of the Keweenawan, it is reasonable to assume that no definable stratigraphic summit exists, but that the Mesabi rocks upwardly blend stratigraphically and structurally into the igneous rocks of the Keweenawan, the beds of passage being simply such conglomerates and sandstones as are well-known parts of the Keweenawan. Not only so, but the red shales, the conglomerates, the sandstones (volcanic sands largely) which are well-known integral parts of the Mesabi, although often changed to iron ore, are identifiable, at least comparable, with similar strata of the Keweenawan.

If we seek for the extension of the igneous Mesabi further east, in Ontario east of Gunflint lake, we have not much field evidence to depend on. At Gunflint lake the writer found the lower beds of the Animikie to contain much flint and this character extends, according to the Canadian geologists, many miles further east; but the very lowest strata at Gunflint lake consist of contorted and handsomely colored jaspilyte, lying on the uneven surface of the Archean granite. The flint and the jaspilyte are essentially of the same composition, chemically deposited micro-granular silica, but differ in structure, one being horizontally stratified and more or less thinly interbedded with black slate such as on the Mesabi range in Minnesota consists largely of igneous debris. The conditions all indicate that there was a period of igneous activity at Gunflint lake, at the opening of the Animikie, that the heated ocean was charged with soluble silica, that this was precipitated along with the sediments of volcanic sand and breccia and that the lava that outflowed was suddenly consolidated as volcanic glass, (obsidian), and was at once permeated by the prevailing soluble silica without losing its fluidal structure, forming the jaspilyte of the region. There could be no nicer and clearer demonstration of the nature and origin of the Mesabi jaspilyte—and the same origin is perfectly applicable to the Archean jaspilyte of the Vermilion range.

When it is once apprehended that igneous agencies were chiefly operative in the production of the parent rock from which the iron ores of the Lake Superior region have been derived by alteration *in situ,* both the Archean and the Taconic, several corollary conclusions follow:

1. Not all the igneous rock can be assumed to have been changed to iron ore, but much of it, especially that which lay on land surfaces, maintained its original composition.

2. It was when the action of the ocean was immediate and direct that the great alterations were produced.

3. The red shales so common in the Keweenawan and occasionally seen in the Mesabi, consisted originally of volcanic and other igneous debris. They sometimes constitute a low-grade iron ore, as at Baraboo, Wis., and at the Mahoning mine at Hibbing, Minn.

4. As these red shales form a great thickness of rock that extends under the eastern and southern part of Minnesota, reaching two or three thousand feet, it follows not only that the oceanic currents of the Taconic age in the Lake Superior region carried their sediments far from the volcanic centers toward the southwest, but that the volcanic activities of the whole Keweenawan age, including the Mesabi, are cotemporaneously represented by that vast thickness of red shale.

It has already been shown in Part III of this series, that while the igneous fragmental character extends throughout the Mesabi section of over two thousand feet, the alteration which resulted in the localization of the beds of iron ore is confined essentially to the bottom of the Mesabi strata. That points clearly to the origination of the ore about cotemporary with the rocks in which it exists—at least it precludes the agency of later, or it might be said *present,* atmospheric or ground water currents. It cannot safely be presumed that causes acting later than the date of the Mesabi formation could so affect the bottom beds everywhere and leave the rest of the two thousand feet practically intact. If there be any iron in the Mesabi rocks, so far as known, it is always at or near the bottom, and, as shown by the foregoing descriptions, if iron ore be lacking in commercial quantities at its wonted stratigraphic place, still the original rock has been profoundly changed at that horizon and the changes are the same as those that are met with where iron ore exists in large amounts. The inference is inevitable that the cause of the ore acted while the bottom beds which contain it were being accumulated. That is, it originated in an epoch of early volcanic activity, and was dependent in a large measure, if not entirely, on the contact of the heated waters of the ocean on the lavas and volcanic ash of the immediate vicinity. At a later date, when the igneous violence had subsided locally or abated, the earlier igneous centers were buried under vast thicknesses of sediment and igneous debris, and this later part of the Mesabi has never been altered. Still, if similar conditions co-existed at some later date within the Animikie age, it is reasonable to suppose that iron ore would have been formed, and hence that it is not impossible that iron ore horizons considerably later than that which is now worked may be discovered, not only in the Mesabi strata but in any other part of the Keweenawan.

If, now, we re-capitulate briefly the results of this investigation, we shall find the following:

1. The mines of the Mesabi range show nearly all the grand, igneous structures seen in the Keweenawan. These were enumerated and in part illustrated in the proceedings of the Institute of 1908.

2. The black slates, so-called, of the Mesabi range consist largely of basaltic igneous material and of volcanic glass the result of sudden cooling of erupted matter, the average proportion being more than 50 per cent.

3. This igneous matter is usually in the form of more

or less rounded pellets, and these can be seen by the naked eye, more or less mingled with quartz which is likewise rounded by beach action, the quartz being most abundant near the bottom of the section.

4. This igneous material has suffered a profound alteration at the horizon of the iron ore, but the greater part of it is simply consolidated, forming with other kinds of sediment, the "black slates" of the region.

5. This alteration has been accompanied by more or less localization of the substances produced, sometimes being beds of so-called chalcedonic quartz, sometimes of kaolin, sometimes of limestone and sometimes of iron ore.

6. Besides actinolite, occasional mica and tourmaline, there was formed a soft, light green mineral which is practically isotropic, which has been called glauconite and greenalite.

7. This green substance serves sometimes as a general matrix for all the other substances, and sometimes retains the round shape of the original pellets.

8. All the other secondary minerals, such as hematite and quartz in particular, and occasionally the actinolite and calcite, also show by their manner of distribution in the thin sections examined, the rounded form of the original pellets.

9. No one of these secondary products, and especially not the greenalite, can be said to be the source of any of the others but they are all co-ordinate and co-temporary products of alteration of the original igneous rock.

10. The beds at, or near, the bottom of the black slates are the only ones, so far as known, which show such profound alteration, and they were probably so changed prior to the deposition of the overlying mass of black slate.

11. The chief agent of this alteration was the heated water of the ocean which covered the region.

12. The volcanic vents of the region, as they became extinct, or as they shifted from the west toward the east, were buried under the sediments that were formed by later vents,

such sediments drifting mainly from the northeast toward the southwest.

The geological bearing of these facts may be summarized briefly as follows:

1. This great igneous formation is the *Cabotian* so named by the writer 1899, and called the lower member of the Keweenawan.

2. While as an igneous formation it appeared as lavas with their varieties, it also gave rise to thick beds of sediments, both tuffs, breccias, conglomerates and red sandstones, as well as red shales.

3. The so-called "red rock" series of rocks, extending from Duluth to Pigeon Point, is due to the metamorphism and even the fusion of this igneous sediment by the outbreak of the great gabbro mass.

4. This event seems to separate the Cabotian from the Manitou lavas, and brings the gabbro and the red rock series into the Manitou.

5. The gentler effects of this great volcanic age, including both the Cabotian and the Manitou, were carried by the prevailing currents of the cotemporary ocean, far toward the southwest, and are seen in a vast thickness of red shale which underlies the upper Cambrian in southern and southeastern Minnesota.

TIME KEEPING SYSTEM OF THE CRYSTAL FALLS IRON MINING COMPANY.

By James D. Vivian, Crystal Falls, Mich.

In the employment of the number of men necessary to operate a mine, the employer is compelled to introduce a system of time-keeping which will insure accuracy in the work, not only as to the distribution of the labor cost to the proper account, but also as to the correctness of the time credited to each employe for the work performed. Many different systems are used at the mines in the Lake Superior district, each of which has some good points, and it is with the idea of bringing out a discussion of the various systems that this paper is presented at this meeting. The best method is one by which a check can be had on the person keeping the time, to provide safeguards against carelessness and dishonesty.

An employe is liable to be mistaken in the number of shifts that he claims to have worked during the month, and should he claim more than the time-keeper shows, a check system against the time-keeper will prove or disprove his claim. The same system would be equally effective should an employe think he had worked less time than his due bill called for. It would not be just to deduct a certain number of shifts, when a checking system might show that the employe had not kept his own time correctly.

In order to provide as many safeguards as possible, the time-keeping system adopted by the Crystal Falls Iron Mining Company, as explained herein, will show that the system has a tendency to keep not only the time-keepers in line, but also the several foremen or bosses, by whom the time is kept.

The men on going to work in the morning, report their

______________ MINE

DAILY LABOR AND PRODUCT REPORT

______________ 191___

Surface	Total	Underground	Day	Night	Total
1 Office, Time, Shipping and Supply Clerks, ...		1 Mining Captain and Ass'ts			
2 Mining Engineer, Chemist and Ass't, ...		2 Mine Foreman, ...			
		3 Miners, Company Acc't, ..			
3 Master Mechanic, ...		4 " Contract, ...			
4 Machinists and Helpers, ..		5 Trammers, Company Acc't			
5 Engine House Floorman, ..		6 " Contract, ...			
6 Brakemen, ...		7 Car Dumpers and Skip Tenders, ...			
7 Firemen, ...		8 Trackmen, ...			
8 Pumpmen, ...		9 Timbermen, ...			
9 Pipemen, ...		10 Ditching & Cleaning Tracks			
10 Carpenters, ...		11 Underground Laborers, ...			
11 Carpenters' Helpers, ...		12 Mule Teamsters, ...			
12 Blacksmiths, ...		13 Car Brakemen, ...			
13 Blacksmiths' Helpers, ...		14 Chutemen, ...			
14 Drymen and Janitor, ...		15 Wheelers, ...			
15 Landers, Pocketmen and Rock Pickers.....		16 Motormen, ...			
16 Stock Pile Trackmen, ...		17 Motor Brakemen, ...			
17 " " Motormen, ...					
18 " " Laborers, ...					
19 Barn Boss and Helper, ...					
20 Teamsters-Swampers-					
21 Crushermen-Crusher Engineers, ...					
22 Surface Foremen, ...					
23 " Laborers, ...					
24 Painters, ...					
25 Wood Choppers, ...					
26 Steam Shovel Operators...					
27 " " Laborers, ...					
28 Masons, ...					
29 Electrician, ...					
30 Boiler Makers and Helpers					
33 Total Men, ...		21 Total Men, ...			
		22 Product per Man, ...			

23 Total Number Men Employed ....
24 Product per Man.................................. ....
Number Cars Trammed............................ ....
Number Skips Hoisted............................ ....
Number Tons Hoisted.......................... ....
Total Product to Date for Month................Days ....
Average Daily Product for Month........... ....
Estimate for Month.............................Days ....
Cars Shipped from Stockpile....................... ....

Summary of Hoist		Day	Night	Total
25 Number Cars Trammed	No. 1 Shaft			
	No. 2 Shaft			
	No.........			
26 Number Skips Hoisted	No. 1 Shaft			
	No. 2 Shaft			
	No.........			
27 Number of Skips Rock Hoisted.				
28 Tons Ore Hoisted..........................				

(Reduced from the Original.) FORM "A"

brass check numbers to the time-keepers (at our mines this is done verbally), who records the same as the men present themselves at the window. The time-keeper, in taking the numbers in this manner, sees each man, and knows that the man has gone to work, whereas, if the numbers were to be deposited by the men themselves one man could deposit more than one number, and later in the shift, those for whom he deposited could slip into their working places. On returning from work at the close of a shift, our men report again in the same manner to the time-keeper.

During the shift (we are working two shifts of ten hours each and have a time-keeper for each shift), the time-keeper sees every man at his work. On surface he makes two rounds each day, once on each half shift. Underground the time-keeper makes only one round each shift, and as he meets the men he records the place in which they are working. This enables him to classify the time according to the accounts kept or classification required for cost reports, etc. The time-keeper at the close of the shift has a good check on his own work, and taking for granted that he has faithfully performed his duties as required, the possibility of an error is remote.

We show herewith the form of daily report made by the time-keeper (Form A) and transmitted to the general office. This is here given to show the similarity of the checking report made out by the different foremen (Form C) and explained later.

This now leads up to the checking system other than that employed by the time-keeper. The surface foreman takes the time of the men employed on surface, regardless of what his employment or connection with any particular branch of the organization may be. The shift boss takes the time of the men underground, likewise regardless of the work they are doing. These several bosses, therefore, take the time of all men employed around the mine.

Each foreman makes out a report for his shift, the surface

1301		1355		1409		1463		1517		1571	
1302		1356		1410		1464		1518		1572	
1303		1357		1411		1465		1519		1573	
1304		1358		1412		1466		1520		1574	
1305		1359		1413		1467		1521		1575	
1306		1360		1414		1468		1522		1576	
1307		1361		1415		1469		1523		1577	
1308		1362		1416		1470		1524		1578	
1309		1363		1417		1471		1525		1579	
1310		1364		1418		1472		1526		1580	
1311		1365		1419		1473		1527		1581	
1312		1366		1420		1474		1528		1582	
1313		1367		1421		1475		1529		1583	
1314		1368		1422		1476		1530		1584	
1315		1369		1423		1477		1531		1585	
1316		1370		1424		1478		1532		1586	
1317		1371		1425		1479		1533		1587	
1318		1372		1426		1480		1534		1588	
1319		1373		1427		1481		1535		1589	
1320		1374		1428		1482		1536		1590	
1321		1375		1429		1483		1537		1591	
1322		1376		1430		1484		1538		1592	
1323		1377		1431		1485		1539		1593	
1324		1378		1432		1486		1540		1594	
1325		1379		1433		1487		1541		1595	
1326		1380		1434		1488		1542		1596	
1327		1381		1435		1489		1543		1597	
1328		1382		1436		1490		1544		1598	
1329		1383		1437		1491		1545		1599	
1330		1384		1438		1492		1546			
1331		1385		1439		1493		1547			
1332		1386		1440		1494		1548			
1333		1387		1441		1495		1549			
1334		1388		1442		1496		1550			
1335		1389		1443		1497		1551			
1336		1390		1444		1498		1552			
1337		1391		1445		1499		1533			
1338		1392		1446		1500		1554			
1339		1393		1447		1501		1555			
1340		1394		1448		1502		1556			
1341		1395		1449		1503		1557			
1342		1396		1450		1504		1558			
1343		1397		1451		1505		1559			
1344		1398		1452		1506		1560			
1345		1399		1453		1507		1561			
1346		1400		1454		1508		1562			
1347		1401		1455		1509		1563			
1348		1402		1456		1510		1564			
1349		1403		1457		1511		1565			
1350		1404		1458		1512		1566			
1351		1405		1459		1513		1567			
1352		1406		1460		1514		1568			
1353		1407		1461		1515		1569			
1354		1408		1462		1516		1570			

(Reduced from the Original.) **FORM "B"**

foreman being obliged to get the time of the few men employed at night, when no regular night surface foreman is employed. He takes each man's number orally, and at the close of the shift fills out the blank here shown (Form B), making a cross (X) after the number corresponding to the brass check number of every man whose time he has taken.

On the reverse side of this report, as shown by Form C, he makes a general classification of the men working on his shift. This classification we consider merely incidental to the real purpose of the report, i. e., getting a check on each man who worked on that particular shift.

This report as made out each day by shift boss or foreman, is then placed in an envelope, sealed, addressed to the superintendent, and mailed to the general office. The bosses and time-keepers are, under no consideration, to compare notes on the time, under penalty of dismissal. These reports as received at the general office, are checked against the report of the time-keepers, and at the end of the month, against the total days of the pay roll. In all cases they must agree.

Assuming that a discrepancy should occur between the time-keepers and foremen, we have provided a blank (Form D) to be used in checking, to find where the error was made. This blank, when filled out, is referred by the general office to the captain of the mine, whose duty it then is to take the books of the time-keeper and shift boss or foreman, and in their presence check the same to locate the error. This is a very easy matter and quickly done. The blank is then filled out as directed and returned to the general office and filed with the reports.

All men are paid by the cashier of the general office, the time-keepers not doing any paying. It has been found that men who were generally classed as the "habitual kickers" on pay days are not now heard from, as they know that when they get their due bills their time is correct, and there is no further cause for a complaint.

The method above described has been in actual use since

__________ Mine, __________ 191___

Surface	Total	Underground	Day	Night	Total
Office, Time, Shipping and Supply Clerks		Mining Captain and Ass'ts			
Mining Engineer, Chemist and Assistants		Mine Foreman			
Master Mechanic		Miners, Company Acc't			
Machinists and Helpers		Miners, Contract			
Engine House Floorman		Trammers, Company Acc't			
Brakeman		Trammers, Contract			
Firemen		Car Dumpers and Skip Tenders			
Pumpmen		Trackmen			
Pipemen		Timbermen			
Carpenters		Ditching and Cleaning Tracks.			
Carpenters' Helpers		Underground Laborers			
Blacksmiths		Mule Teamsters			
Blacksmiths' Helpers		Car Brakemen			
Drymen and Janitor		Chutemen			
Landers, Pocketmen and Rock Pickers		Wheelers			
Stock Pile Trackmen		Motormen			
" Motormen		Motormen Brakemen			
" Laborers					
Barn Boss and Helper					
Teamsters—Swampers—					
Crushermen—Crusher Engr's—					
Surface Foremen					
" Laborers					
Painters					
Wood Choppers					
Steam Shovel Operators					
Steam Shovel Laborers					
Masons					
Electrician					
Boiler Makers and Helpers					
Total Men		Total Men			
		Grand Total Men			

(Reduced from the Original.) FORM "C"

the early part of 1902, and has proven very effective. At the time the reports were first introduced at the older operating mines, the shift bosses objected to the clerical work involved, but once fairly started, it has had no drawbacks and is in general favor.

CRYSTAL FALLS IRON MINING CO.

....191......

Captain........................

........................Mine

Dear Sir:

The following discrepancies appear on the Daily Report of............................191..

	DAY	NIGHT	REMARKS:
Daily Report	....	....	....
Shift Boss	....	....	....
Sur. Boss	....	....	....
....	....	....	....
....	....	....	....

Please locate the discrepancies and return this slip with your findings.

W. J. Richards, Gen. Sup't.

....

REPORT:

....

Captain

FORM "D"

SOME PRACTICAL SUGGESTIONS FOR DIAMOND DRILL EXPLORATIONS.

By A. H. Meuche, Houghton, Mich.

The volumes of the Lake Superior Mining Institute contain many articles on diamond drilling. Most of these papers deal with the curvature of drill holes and methods of observing the true angle of dip. As a result of these papers the diamond drill operators are supposed to test the angle of their holes at frequent intervals and then the angle etched on the bottle is corrected for capillarity. I am heartily in accord with this survey of bore holes but often wonder, inasmuch as no attempt is made to determine their lateral deflections, if these surveys and corrections are really worth while.

Besides these there are many matters which should be considered by anyone having lands explored by means of diamond drills. Two of the most important are the preserving of the bore holes and the preserving of the records. In the Copper Country, where I have had most of my experience, the usual practice is to pull out the stand pipe when the hole is completed, thus making it impossible to reopen the hole and continue it to a greater depth, if the occasion should ever arise when it might be advisable to do so. Of course, this question must be answered separately for each and every drill hole, as it becomes necessary to consider the policy of the parties having the drilling done, the cost of leaving the casing compared to the total cost of the hole, and whether or not for geological reasons it is definitely known whether any occasion may ever arise for deepening the hole. By this I mean that you know definitely that ore does not lie at any greater

In the Copper Country geological conditions answer the question many times. Here, as most of you know, the beds usually have a pretty steep dip and cross-sections are made by drilling a series of holes in a line at right angles to the strike and placing these far enough apart so that the bed exposed in the bottom of one hole is also found in the top of the adjacent hole.

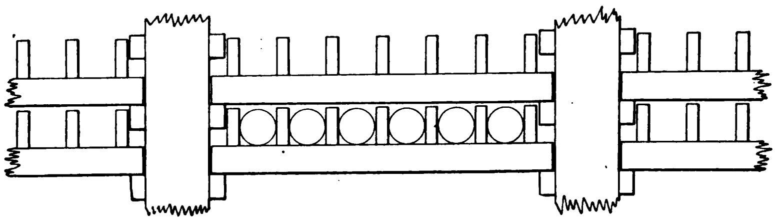
There are two methods in which cross-sections are drilled. The most logical is to start at the extreme eastern limit of your property or at the limit of the copper bearing range, and work west. In this method it is necessary to bore the holes until you are positive of having a lap. The objection to the method is that it is not always possible to bore the holes as deep as you wish to go and then it is necessary to put down an intermediate hole. The other method is to start from the west and drill your hole as deep as you can, or desire to, compute the horizontal distance covered by the hole, deduct a little for lap and locate your hole to the east. This method works fairly well, especially for two drills, but is open to many objections. Suppose you find a fairly rich copper bearing lode, near surface, in one hole and would like to examine it at depth. It may only be a few feet below the bottom of your preceding hole, but if it has been discontinued and the pipe pulled out, these examinations would necessitate a new hole, duplicating largely work which has already been done. Again you may make a mistake in your computations, or the dip may be steeper than you thought it was. Under these circumstances you may have a gap in your section. Another trouble lies in the fact that even though the holes do lap, you may not be able to recognize them.

All these objections and troubles occur quite frequently and have come within my own observations. Ordinarily the first method is the better one to follow, but there are many times when it is advisable and sometimes necessary to use the second. If the latter method is used, I strongly advise leaving the stand pipe.

Another matter which has become a sort of hobby of mine is the care and preservation of drill cores. Perhaps this is due to the fact that I have examined in the neighborhood of a hundred thousand feet of drill cores during the last few years. I have seen cores kept in a limited number of boxes; when these boxes became full the cores were dumped out and the boxes refilled. I have seen core boxes kept in a cold, wet cellar, one box piled on top of another, forming a high stack. Often the lids are nailed down tighter than the bottom is nailed to the box, so that in trying to pry off the lid the box falls to pieces. I have climbed upon racks, pulled out boxes (not having covers) that were slipped in sideways, balanced them on my finger tips and tried to get down. Once or twice the boxes turned up side down.

With these experiences you can readily perceive why the method used by the Victoria Mining Company and later adopted, with some minor changes, by the Mass Consolidated Mining Company, appeals to me. In both cases they have rigged up a sort of cabinet, using the core boxes without lids as drawers. The boxes slide lengthwise into a rack or cabinet. The boxes or trays are stacked so close together that the bottom immediately above acts as its cover. At the Victoria, a strip the full length of the box is nailed on either side forming the slides for the drawer. A drawer-pull and a label giving the number of the hole and the depths of the hole from which the core was taken is fastened to one end of the box. At the Mass they have overcome the necessity of nailing strips to the sides of the box by allowing the bottom of each box to extend about half an inch on either side. The boxes are made about five feet long, which is a convenient length to handle, and holds enough core for ordinary purposes. The cabinet itself is made very similar to any ordinary cabinet, holding drawers, except that it is not necessary to put a piece of wood under each drawer as a stiffener. If the sides are made of two inch material, a stiffener need only be introduced about every ten boxes. Sides or partitions are made for each stack of core boxes and as high as desired. These had better be made pretty heavy as they must support the entire weight of all the boxes in each stack, and in order to make the construction as slow burning as possible, I would suggest a tight partition. Strips are nailed on both sides of these partitions to catch the strips on the boxes, thus supporting them. These strips should be placed just far enough apart to allow easy and free sliding of the boxes.

The accompanying sketch will explain the construction fully. The advantages of this system are the convenience in refer-



SKETCH SHOWING BOXES IN RACK.

ring to the cores at any time and small amount of space required. Each box occupies a space of 10⅞x2 3-16 inches. Allowing one stiffener for every ten boxes, thirty boxes can be stored in a stack five feet nine inches high. As each box holds thirty feet of 1⅛ inch core, which represents approximately forty feet of drilling, one stack would represent 1,200 feet of drilling. Ten such stacks representing 12,000 feet of drilling, would only occupy a space six feet high, ten and one-half feet long and five feet deep. I do not believe that the same number of boxes with covers screwed on could be gotten into the same space, and I question if the lumber and screws used for a cover would cost as little as would this scheme. The only objection to the scheme is the trouble involved in transporting the boxes from the drill. The Mass Mining Company solved this by making boxes with hinged covers and locks which would just hold one core box. The core box was then placed in the box, which was then locked and sent to the mine office. For shipping, the core boxes could be crated readily enough.

I wonder, with such a convenient method as this of storing cores, if as much core would be thrown away as is now done. After so much money has been spent in obtaining the records it seems too bad to see the true records destroyed. I often encounter the argument "Of what good are they?" They usually are no longer of any use to you, but someone else may examine them and see something of great scientific or practical value. There is some excuse for a person holding merely an option on a piece of land to throw away the cores, as he may not have any place to store them, but in those cases I truly believe that the Geological Survey should make an attempt to preserve the records.

STANDARD BOILER HOUSE AND COAL HANDLING SYSTEM OF THE CRYSTAL FALLS IRON MINING CO,. MENOMINEE RANGE.

By J. S. Jacka, Crystal Falls, Mich.

One of the first questions to be decided in the construction of the power plant is its location. This depends largely upon the location of the shaft, the ease with which coal may be brought to the boiler, and means of storing the coal, especially in the winter.

The first factor, the location of the shaft, is one that has an important bearing upon the location of the engine house. The building must be so situated that the cable will have as few sharp bends as possible, and still be comparatively close to the shaft. The cost of handling the coal and ashes is usually the largest item in the operating charges. In plants as found at some of the smaller mines, the amount of fuel and ash handled does not warrant the expense of an elaborate conveyer system, which would be justifiable in larger plants. In whatever way the fuel is supplied provision must be made for storing a quantity sufficient to operate the plant for some time, in case supply is interrupted, to guard against an enforced shut down.

The type of building should next be considered. It must be as near fire proof as possible, cheap in construction, and should be flexible enough in the design to make it conform to the various local conditions found at the mines and still retain the same general shape or plan. This has been the aim in all of the installations at the Crystal Falls Iron Mining Company's properties. One set of drawings has been made and they have been used in the building of all boiler houses, with only slight variations as were necessary at the mine. For lack of a better word this has been called the "standard" boiler house of the Crystal Falls Iron Mining Company. The term is not used to imply that one boiler house is the exact counterpart of another, but that certain features of its construction and details have been so standardized that as a whole it may be termed a "standard" boiler house.

The boiler should be of a type such that its first cost will be low, and still give a maximum efficiency with a minimum amount of expense for its upkeep. As affecting fuel economy the boiler equipment is by far the most important part of the power plant and involves the largest share of the operating expense. It matters little how elaborate, modern, or well designed it may be, skill, good judgment and continued vigilence are required on the part of the operator to secure the best efficiency.

Of the various types and grades of boilers on the market experience shows that most of them are capable of practically the same evaporation per pound of coal, provided they are designed with the same proportions of heating and grate surface and are operated under similar conditions. They differ, however, with respect to space occupied, weight, capacity, first cost, and adaptability to particular conditions of operation and location. The boiler used by the Crystal Falls Iron Mining Company is of the fire tube type. This boiler is simple, inexpensive, and when properly operated is found to be durable and economical. The installation and removal of this type of boiler gives it an advantage over the water tube boiler, especially in mining work, where the life of the plant is comparatively short. The number of boilers installed at any one plant in no case exceeds six boilers, and as there is always plenty of floor space the addition of extra boilers would only involve the cost of installing the boilers themselves. For low pressure and small power the return tubular boiler has advantage of affording a large heating surface in a small space, and large overload capacity, a condition to be desired in furnishing steam for hoisting engines. The first cost of this boiler is low, which gives it another advantage over the water tube boiler.

The boiler shown on plate I practically conforms to the specifications of the Hartford Steam Boiler Inspection & Insurance Co. The "standard" is a 72"x18' horizontal return tubular boiler having 68 four-inch tubes. The shell is made of open hearth flange steel plate ½" in thickness. The heads are 9-16" in thickness. The longitudinal seams in the shell are the butt joint double covering strip type triple riveted. The firth seams are single riveted lap joint. These riveted seams are proportioned so as to secure the strongest possible joint. The braces in each case, together with their rivets, have been carefully calculated for the pressure they are to bear, and are so distributed that all parts of the surface braced may be sustained. The boiler has a 11"x15" manhole in the front end below and in top shell above tubes. The front is the full arch flush type. The flush front costs a little more than the extended front for brick and setting, but it is more convenient to operate and the boiler is less expensive.

Plate I shows longitudinal section of the boiler setting. This setting is the same regardless of the number of boilers, and is made of hard red brick laid in lime (or cement) mortar and the entire setting is lined with fire brick up to the center line of the boiler, as shown in the drawing. Every fifth course is laid with headers, so that any part that might become damaged can be easily renewed without taking out the entire lining. In the drawing the grate width is six inches less than that of the boiler, and the side wall is battered so as to leave a space at the level where the setting closes into the boiler. The top of the bridge wall is 12" from the bottom of the shell and the space behind is left empty. Curving this combustion chamber to conform with the shell only reduces its size, which is a disadvantage with bituminous coal. The rear wall is 30" back of the rear head, which makes the chamber larger. The back connection, i. e., the connection between the rear wall and the head, is a source of more or less trouble on account of the expansion and contraction of the boiler, and the difficulty of making a joint that will remain tight. One method is to spring an arch across having one end resting on the wall and the other upon an angle fastened to the back head of the boiler. The arch consists of brick resting in an iron frame work. Another method used is to place steel rails across the setting latterly and fill in the spaces between the rails with brick.

It is sometimes difficult with low grade fuels and natural draft to burn sufficient coal in the grates of a horizontal tubular boiler to produce the evaporization needed. For this reason it is necessary that the grate surface be as large as possible, and have the maximum rate of combustion per square foot of grate surface for the draft obtained.

The suspended support is used as this seems to be the best method. The boiler, being independent of the walls, does not get out of alinement with the settling of the walls, which is almost sure to occur. When the boiler is set on the lugs the settling of the walls often throws the support of the boiler on two lugs thus setting up severe torsional strains in the boiler shell. The boiler is set high in front in accordance with general practice. The expansion and contraction of the fire brick causes the boiler to settle in front and it invariably gets lower than the rear end; this necessitates the raising of the front end.

While this setting has been very satisfactory and has given good service it was thought advisable to try some other type of boiler in order to eliminate, if possible, the settling and cracking of the walls. With this in view a Casey-Hedges patented standard steel setting was installed after carefully considering several different types. This setting appears to present means of overcoming the defects in the all-brick setting and still retains the good features of the old setting. This setting does away with the heavy brick work walls. It is lined first with a layer of asbestos, then a layer of red and a layer of fire brick. There is a notable absence of heavy foundations, the only ones of any consequence being beneath the supporting columns from which the boiler is suspended. The barrel of the casing is semi-circular in shape, being practically an inverted Dutch Oven, holding the heat to the boiler as the hot gases pass from the furnace over the incandescent fire brick into the combustion chamber. This setting is cheaper to install and requires less brick. The only repairs necessary is the relining of the furnace, thus lowering the cost of maintenance as compared to the brick setting.

In selecting a grate bar that was cheap and would give adequate support to the coal and yet permit the access of sufficient air from below for combustion, it was found that the Wicks rocking grate gives the best service as compared with the stationary grate; while the initial cost is greater the rocking grate out-lasts the stationary grate.

The steam line leading to the shaft is connected to an auxiliary 5″ header, or by-pass, besides being connected to the main header. This affords a means of making repairs or additions to the main header without stopping the mine pumps. This auxiliary line also supplies the feed pumps. The Hoppes feed water heater or purifier is used and is the open type of heater. This style of heater has several advantages over the closed type, namely, it is lower in first cost, is more easily accessible for cleaning and repairs, scale and oil do not affect the heat transmission. It has the disadvantage in that the oil becomes mixed with the steam, but by keeping them clean and using oil traps this difficulty is reduced to a minimum.

The means by which coal may be placed within reach of the fireman presents a more difficult problem in a plant of this size than it would be in a larger one. The method used is to make a space similar to a stockpile ground. A trestle is built the entire length of this space and the railroad cars are unloaded from it. A narrow gauge portable track is then laid from the coal pile to the boiler house and by means of an inclined track laid on timbers the car is elevated above the coal bunkers. A ton and one-half car is used to convey the coal. The car, designed for this, works automatically. The doors are placed in the bottom and are opened by a system of levers and a spring. A dog engaging a "dump pin," which is fastened to the timbers and is adjustable as to location on the timber, releases a catch letting the doors drop open. When the car starts on its return journey a flat piece of iron attached to the runners, upon which the rails are laid, automatically closes the doors. The car, as shown on plate III, is built low in order to make it easier to shovel into. A small hoisting engine in the boiler house is used to pull the car. This method of handling the coal is very simple and can be adapted to suit almost any condition that may arise in the location of the coal pile. The manner in which the car enters the boiler room is shown in plate II.

RECORDING AND SIGNALLING DEVICE FOR MINES.

JOHN M. JOHNSON, ISHPEMING, MICH., INVENTOR.

The present invention was devised more particularly for making records of mine operations, but undoubtedly many features thereof are useful in connection with other work of a somewhat analogous character.

One of the primary objects is to provide novel and practical mechanism of a comparatively simple nature that will record the operation of elevating mechanism, showing the number of trips or loads, the places from which such loads are taken together with all stops, delays and the like.

Another and important object is to provide means for recording the character or grade of ore or other material transported, and the levels or places from which the same are taken.

Still another object is to provide a signalling system which, while useful *per se,* also combines with the afore-mentioned means or mechanism to produce a semi-automatic apparatus in which the signal to the operator of the hoisting mechanism effects the operation of the recording means.

Recording Mechanism for the Elevating Means—Taking up this recording mechanism, in detail, a suitable frame is employed, in which are mounted a pair of stationary vertical shafts having gear wheels journaled on their lower ends, said gear wheels being in mesh with an intermediate idler. These shafts are surrounded by skeleton frames, secured to the gear wheels, and on said frames are detachably slipped winding drums, preferably in the form of open ended cylinders. These cylinders have at their lower ends inset lugs that engage in sockets carried by the skeleton frames and consequently the drums and frames are held against relative rotation. One of these drums is designed to carry a record receiving sheet that is unwrapped therefrom, and wound upon the other drum. Said other drum is therefore provided with suitable tines to engage the end of the sheet. For the purpose of removing the record sheet when the receiving drum has the same thereon, said drum is provided at its lower end, with an opening so that the rolled sheet can be grasped between the finger and thumb, and withdrawn from the drum or cylinder when said cylinder is detached from the skeleton frame. The drums are operated by a suitable time movement. This time movement may be of any suitable character so that it is absolutely accurate. It is carried by a frame that is hinged to the rear side of the main supporting frame, and has a gear wheel in mesh with one of the gear wheels. By having it hinged, it may be swung downwardly and out of the way, in order to permit the drums to be readily removed and replaced.

By referring to Fig. 2, it will be noted that the record sheet has its main portion divided into two longitudinal spaces and the margins of said spaces being provided with scales indicative of the divisions of time, as will be evident, and it will be clear that as the winding drums are revolved by the time movement, this sheet will be slowly unwound from one drum, and wound upon the other. Interposed between the drums is a vertical platen across which the sheet operates, and co-operating with this platen on the exposed face of the sheet is a vertically movable recording or marking device preferably in the form of a fountain pen having a suitable filling funnel. The pen is slidably mounted in a pair of upstanding ears carried by a supporting arm that is vertically slidable in a guide, and has a threaded engagement with a vertically disposed rotating screw shaft. The marking device has its rear end offset, and mounted on said marking device between the ears, is a yoke. This yoke is ordinarily secured against movement on the marking device by a set screw, and has a depending pintle borne against by one end of a lever that is journaled between its ends on the arm. A spring connected to the other end of the lever and to an adjusting screw, serves to yieldingly maintain the marking device or pen against the record sheet. The adjusting screw is carried by a supporting bracket fastened to the arm.

The screw shaft is journaled in two horizontal bars of the supporting frame, and is geared at its lower end to a horizontally disposed shaft. This shaft extends in any suit-

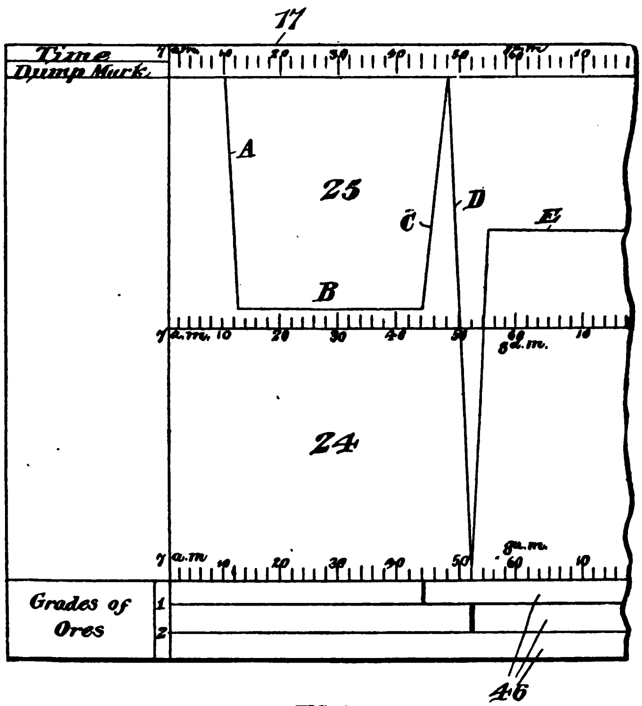


FIG. 2
Face View of a Portion of One of the Record Sheets.

able direction and projects from the frame. It has secured thereto a sprocket wheel and the sprocket chain, passing around the wheel also passes around a sprocket wheel carried by the hoisting drum. It will be understood that the gearing between said hoisting drum and the vertical screw shaft is such that the operation of said drum from one level to another will rotate the screw shaft sufficiently to carry the marking device across the lower space of the record sheet, and a movement of said drum sufficient to elevate the skip from the level to the dumping point will carry the marking device from the intermediate line of division to the dump mark indicated on said record sheet.

The operation of this portion of the mechanism is believed will now be obvious. The time movement operates at a proper rate of speed, to carry the record sheet past the marking point, according to the time indicated on said record sheet. The said sheet having been properly started, will continuously operate, and therefore the marking device or pen will make a continuous line thereon. If the winding drum is rotated to lower the skip to the first level, a line, as A in Fig. 2, will result, for the screw shaft being simultaneously rotated, will carry the pen downwardly. After reaching the level if a delay occurs, a horizontal line, as B, will show the length of such delay, and if the skip is now elevated to the dumping mark, another upwardly extending line, as C, will be the result. If for instance, the skip is then lowered to the second level, the line D will clearly show the same, and if a breakdown or other accident occurs, to cause the skip to stop at an intermediate point, a horizontal line, as E, will show the same, and also clearly indicate the length of the delay. Thus a complete record of the operation of the elevating mechanism will be produced.

It will of course be understood that the mechanism may be used in connection with any number of levels, two being shown in the present instance, Fig. 1, for the sake of simplicity. Also these levels may be located at various depths requiring only the change in the arrangement of the record sheet and in the gearing which is interposed between the winding device and the vertical screw shaft. It is also worthy of note that the threads on the screw shaft terminate short of the horizontal bars, in which said shaft is threaded. This is important for the reason that if the winding drum for any reason should be operated beyond the limits of movement of the marking device, said device will merely disengage from the threads and prevent breakage of the parts. It will be understood that a number of the detachable cylinders may be employed in order that no great delay may take place in changing the record sheets, particularly when the mine is operated continuously.

Grade Recording Mechanism—It will be noted that the lower margin of the record sheet, Fig 2, is provided with longitudinal lines of spaces in which the grades of ores elevated are recorded. This recording mechanism is preferably construct-

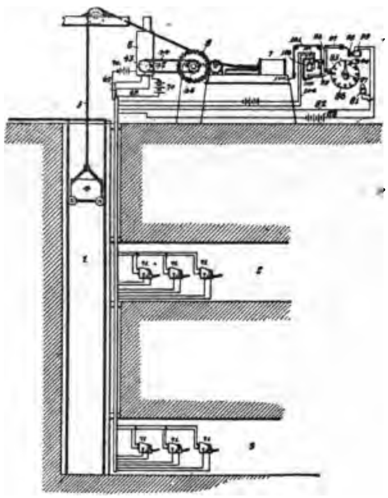


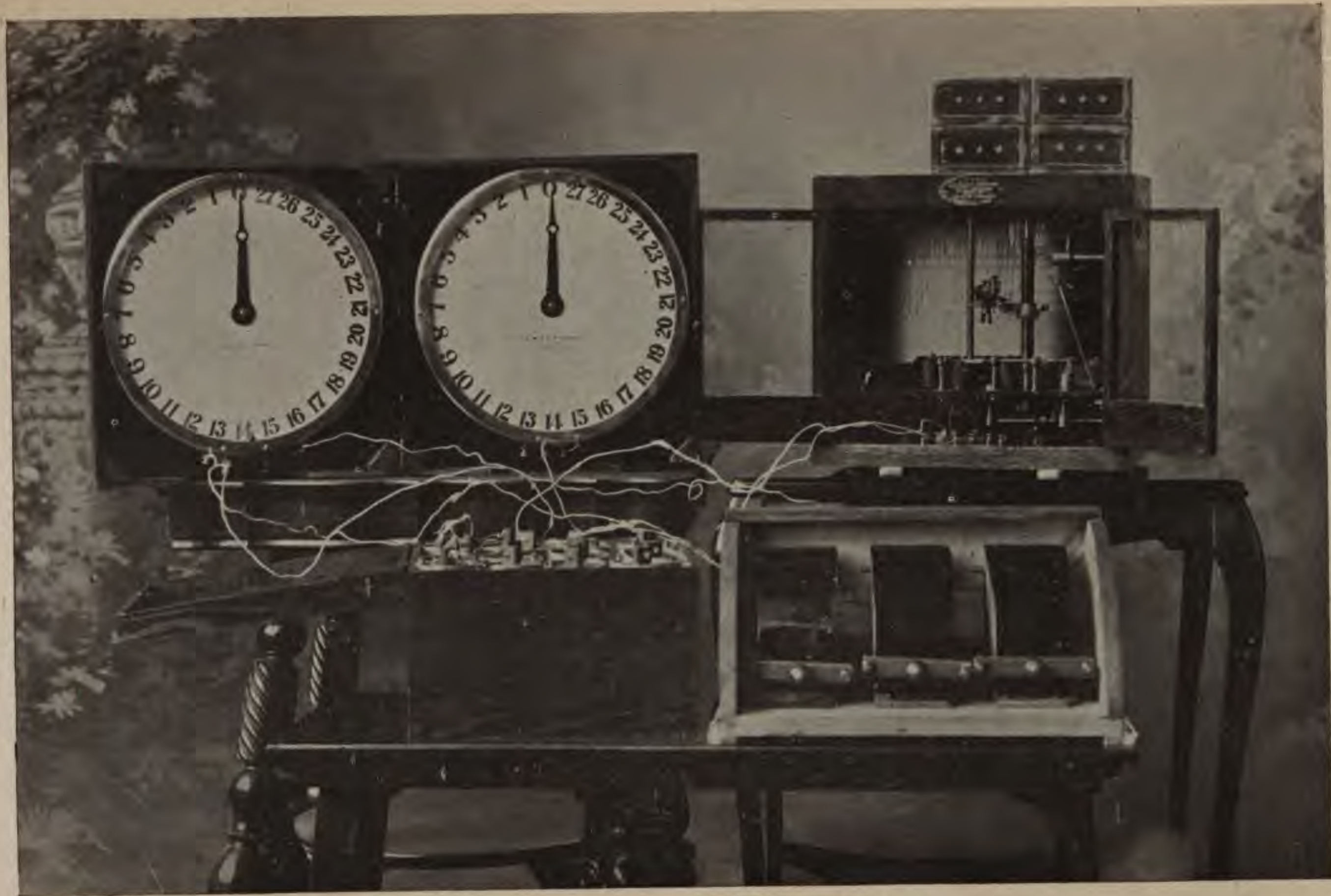
FIG. 1
Diagrammatic View of a Mine, Showing the Recording System Installed.

ed as follows: Two hammers are employed, though any number may be provided depending on the number of grades of ore or material which it is desired to make record of. These hammers respectively have their heads movable against the different spaces in vertical alinement with the marking device. They are pivoted between their ends, and their lower ends are connected by links to swinging arms that are attached to the armatures of electro-magnets. Interposed between the hammer heads and the record sheet is an inking ribbon that passes around a plurality of rollers and has retaining cords on its margins, which cords engage in grooves formed in the peripheries of the rollers. A step-by-step movement is given to the ribbon in order that a fresh portion will always be located in the paths of movement of the hammers. To this end, one of the rollers has a ratchet wheel secured to its upper end, and a spring-pressed dog carried by a reciprocatory bar, operates on the ratchet wheel. Another spring-pressed dog engaged with the ratchet wheel, prevents the retrograde rotation of said wheel, and consequently a similar movement on the part of the ribbon. The reciprocatory bar has a link connection with a bell crank lever, and this lever in turn has another link connection with a swinging actuating lever. The lever has outstanding cam shoulders, either of which swings into the path of movement of the pen supporting arm when the other is moved out of said path. A spring carried by the lever and operating against a pin serves to hold said lever in either of its two positions. With this construction therefore upon every upward and downward movement of the pen supporting arm, the lever will be caused to rock back and forth, thus through the connections and effecting a reciprocation of the bar, and causing the dog to effect a movement of the ratchet wheel and of the ribbon.

The electro-magnets are in independent circuits that include suitable sources of electrical energy and these circuits extend downwardly to the different levels where they are provided with circuit closers or switches. Each closer comprises side plates to which are attached terminals and a swinging operating lever pivoted to and between the side plates has pivoted thereon a swinging arm that carries a cross bar. This bar operating on the edges of the walls, is movable across the terminal, thus connecting the same, and closing the circuit. A spring serves to yieldingly hold the arm downwardly with the cross bar upon the walls. Brackets are fastened to said wall and have elevating dogs pivoted to their ends and extending over the free ends of the terminals, these dogs being held downwardly upon the edges of the side walls by springs. With this construction therefore, if the cross bar is in its rearmost position in rear of the dogs, upon the forward movement of the lever the cross bars will operate beneath the dogs and engage the terminals, said cross bar will then pass beneath the free ends of the dogs and consequently upon the return movement of the operating lever, the cross bar will ride upon the dogs and will be bridged thereby from the terminals so that the circuit will not again be closed. Upon the closure of either of the circuits, it will be evident that the electro-magnet in that circuit will be energized. Consequently the armature being operated, will cause the hammer connected thereto to be swung and the head, striking the ribbon, will cause a mark upon the record sheet in one of the spaces intended for recording the grade of ore. The operator therefore in the mine at the desired level, uses this mechanism to indicate the grade of a skip of ore that is about to be elevated, but the circuit closer also constitutes a part of the mechanism for signalling the engineer or operator of the hoisting mechanism, and this signalling mechanism is constructed and associated with the recording means as follows:

Signalling Mechanism—An electric bell of any well known form, located in the engine house or at the proper point with relation to the hoisting mechanism, is included in an electric circuit and also includes a suitable source of electrical energy. This circuit extends down into the mine, and has spaced terminals secured in the circuit closers, and in the path of movement of the cross bars of said circuit closers. It will thus be clearly evident that when a skip is to be hoisted from the mine, the person in control at the level from which it is to be hoisted, has only to operate the proper lever indicating the grade of ore in the skip. Upon the initial movement of said lever, the circuit will be closed to make a record of the grade of ore upon the record sheet, and directly thereafter the cross bar of the circuit closer will connect the terminals of the circuit whereupon the bell will be sounded, and any number of strokes of the bell may be made, provided the arm is not completely returned over the bridges. The record of the grade of the ore therefore also acts as a record against the engineer in charge of the hoisting mechanism, for the mark made by the hammer will indicate in connection with the mark made by the pen, whether or not there was delay in answering the signal to raise the load. There is also preferably employed a visual signal for the engineer, the same comprising a rotary pointer that operates over a dial properly numbered as shown. The pointer is connected to a shaft on which is mounted a ratchet wheel and a pinion. The pinion is in mesh with a gear wheel to which is connected a return spring. An actuating dog operates on the ratchet wheel to effect a step by step rotation thereof and a consequent winding of the spring. The return movement of said ratchet wheel after its movement by the dog is prevented by a swinging dog pivoted at one end, and thus being movable into and out of coaction with the ratchet wheel.

The operating dog is connected to the lower end of a lever fulcrumed between its ends, and having a link connection with the armature of an electro-magnet. This electromagnet is in the circuit with the bell and therefore every time said circuit is closed, the armature will be actuated. This will cause the movement of the dog, and the consequent rotation of the pointer, the dog preventing the return of said pointer after each movement. However, if the arm or dog is raised, the spring reacting on the wheel and pinion will immediately return the pointer to zero. This movement of the dog is effected by a suitable handle having a cable connection with a lever which in turn has a cable connection with the dog, said handle being disposed in a convenient position to be grasped and operated by the engineer in charge. To the lever is connected a return spring which normally maintains said lever against a stop. It sometimes may happen, however, that the engineer is not present or for some other reason, it is desired to repeat the signal. It will be evident that the mechanism must be such that a repetition of the signal will not operate



View Showing Complete Recording Machine and Signal Dials the recording mechanism, and also it is necessary that such repetition will not merely advance the pointer. Therefore at each level there is provided an additional circuit closer and constructed exactly the same as those already set forth. The terminals of this circuit closer are a part of a circuit that includes a source of electrical energy and an electro-magnet. This magnet has an armature co-operating therewith, and a link connected to the armature is connected to a lever. The lever has one end disposed beneath the end of the dog. The other terminals of the circuit closer, are connected to the circuit. Bridge dogs are mounted over the terminals. An actuating lever forms a part of the circuit closer and has attached thereto the usual cross bar corresponding in all respects to the cross bar of the above described circuit closers. Assuming therefore that a signal has been given to the engineer at the top of the shaft, and it is desired from any cause to repeat the same, the operator at the level from which the load is to be taken, operates the circuit closer. As the cross bar moves over the terminal the circuit will be closed, thus energizing the magnet which draws its armature. As a result the lever will be operated, which will raise the dog so that the pointer will return to its original or zero postion. The movement of the lever of the circuit closer, being continued, the cross bar will strike the terminals, thus closing the circuit and the signal can be repeated. The return of the lever and cross bar to its original position will not effect the operation of the dog, as said cross bar will be bridged from the terminals by the dogs.

Registering Mechanism for the Loads—Besides recording the number of loads of different grades of ore on the record sheet, registering mechanism is also provided so that the number of loads can be ascertained at any time at a glance without the necessity of an inspection of the complete record sheet. To this end, there is mounted upon the supporting frame, a plurality of registers the number of such registers depending on the number of grades of ores to be recorded and registered.

Thus it will be evident that any number can be employed. These registers may be of any well known type. In the present form, each consists of three number wheels, each of those having the lower orders of digits, being provided with means for effecting an increment of movement of the next upon each complete rotation. Operating on the teeth of the wheel having the lowest order of digits, is a swinging yoke that is carried by a vertically reciprocating actuating bar. These bars have pivoted to their lower ends, abutment blocks that are located in the path of movement of the supporting arm of the marking device or pen. The actuating bars furthermore have notches in their rear sides, and holding dogs pivotally mounted between their ends on the supporting frame, engage in the notches. The dogs have their free ends upturned, as illustrated and these ends are located in the path of movement of the offset terminals of levers, fulcrumed between their ends upon the platen. Reciprocating yokes horizontally disposed and embracing the hammers are mounted in hangers and have their rear ends pivotally connected to the levers. These yokes are urged forwardly by springs.

Assuming now that the actuating bars are in their elevated positions and are locked by the dogs, and also assuming that a loaded skip at one of the levels is about to be elevated, one of the switches is operated, and as already explained, one of the hammers is actuated to record the load upon the record sheet. The hammer in turn operates one of the yokes, causing the movement of the lever and of the dog, which thus releases the actuating bar, and permits it to fall. The yoke therefore drops beneath the lower tooth of the number wheel, and as the skip reaches the dumping point, the pen carrying arm will strike the depending block of the depressed actuating bar, causing the same to move upwardly and rotating the number wheel one increment. Thus the operation of the register is dependent upon the load properly reaching the surface. It will thus be seen that the mechanism disclosed, records the operation of the elevating mechanism, produces a record of the grades of ore, the number of loads and the levels from which they are taken, besides recording the time at which the different loads are ready to be hoisted, and maintaining a check against those in charge of the hoisting mechanism. Both oral and visual signals are provided for the operator in charge of the hoisting mechanism, with means for repeating signals without causing confusion and without effecting improper operations of the recording mechanism, while registering mechanism, dependent on the recording means, is provided for showing the number of loads of the different grades actually elevated, preventing mistakes or fraud in the operation of the recording means.

From the foregoing, it is thought that the construction, operation and many advantages of the herein described invention will be apparent to those skilled in the art, without further description, and it will be understood that various changes in the size, shape, proportion, and minor details of construction, may be resorted to without departing from the spirit or sacrificing any of the advantages of the invention.

SURVEYING AND SAMPLING DIAMOND DRILL HOLES.

By E. E. White, Ishpeming, Mich.

Diamond drilling is expensive work, costing rarely less than $2.50 per foot in the Lake Superior iron district, and often reaching $5.00 per foot in hard ground, or even more if any of the many difficulties known to drillmen are encountered. Yet up to a few years ago little attention was paid to determining the actual course of holes underground, to accurate sampling and analysis, or to scientific location of drill holes. A description of the methods which have been developed in the course of extensive explorations by the Cleveland-Cliffs Iron Company in the Lake Superior district will perhaps be interesting to the members of the Institute.

It has now been common practice for several years to test the inclination of drill holes by etching glass tubes with hydrofluoric acid and the apparatus used by the Cleveland-Cliffs Iron Company has been described by Mr. J. E. Jopling in a paper read before the Institute in August, 1909. In an article which appeared in the Engineering and Mining Journal of September 17th, 1910, I described how the curvature of a diamond drill hole can be controlled and gave an example where it had been done successfully. Although the hole kept to the desired course, it failed to intersect the ore encountered in a previous hole because the direction of deviation from the vertical of the previous hole had not been determined, although the amount of deviation had been determined by the usual hydrofluoric acid tests.

This failure to secure results led to my investigating the question of determining the course, as well as the inclination, of drill holes. After considering several methods two were chosen for trial, one of which has proved satisfactory, the other moderately so. In non-magnetic rock formations the old method of a compass suspended in gelatine is successfully used with improvements worked out by Mr. George Maas and myself. Mr. Maas has patented his improved compass and his idea of using a thermos bottle in connection with the compass and gelatine. In magnetic for-

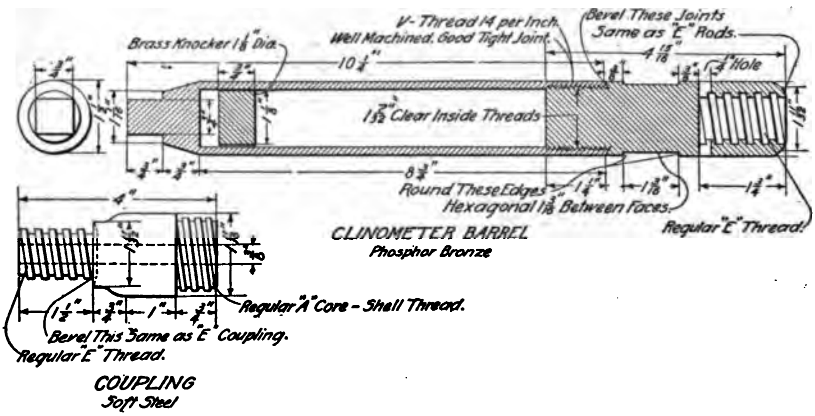


FIG. 1

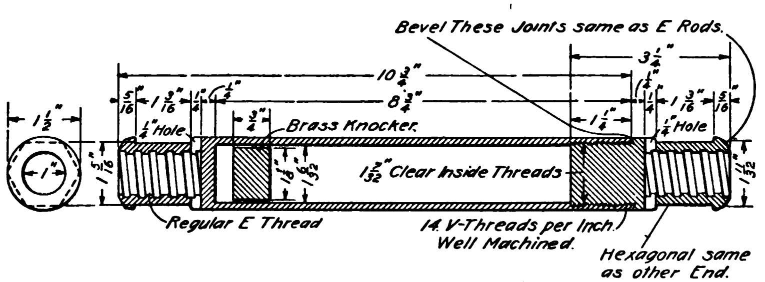


FIG. 2

mations a method of marking the drill rods is used in connection with hydrofluoric acid tests. This method was described to Mr. J. E. Jopling by Mr. John Deacon, superintendent of the Republic Iron & Steel Company's properties at Negaunee, who used it in testing diamond drill holes at the Cambria mine. We did not find it as successful as using a compass, but it is the only method which I know of that is practicable in magnetic formations.

SURVEYING IN NON-MAGNETIC FORMATIONS.

Figures 1 and 2 show the cases used to test for inclination and course. The latter shows the case used when it is desired to make more than one test at the same time, as it may be inserted at any point in the drill rods at the same time that the first case is used at the end of the rods. As it is desired to use as large a glass tube in the case as possible, and as the outside diameter is limited by the size of an "E" hole, a material was selected which combined the greatest possible toughness and tensile strength with non-magnetic properties. Phosphor bronze was chosen, which is entirely

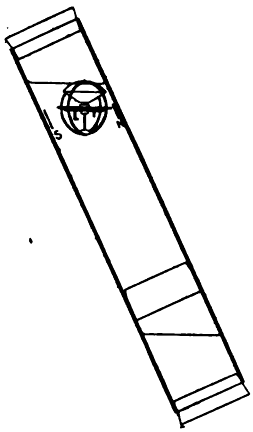


FIG. 3

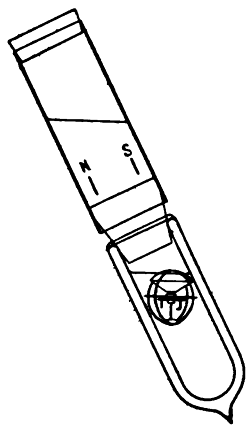


FIG. 5

non-magnetic and for which the manufacturers guarantee a tensile strength of 70,000 pounds and elastic limit of 55,000 pounds per square inch. By using a case of dimensions given in Figure 1, a glass tube 1⅛" outside diameter can be used and according to Nystrom's formula for the collapsing strength of small tubes $P = \frac{4Tt^2}{fd\sqrt{L}}$, using a factor of safety of 4, this case should be safe in a hole 3,300′ below water level. A little wicking is used to make a perfectly tight joint.

The compass invented by Mr. Maas is shown in Figure

3. Its advantage over the old forms of compass used for this purpose lies in the fact that it is pivoted in a cage which prevents its coming in contact with the glass tube and insures its swinging freely in the gelatine. The cage is below and rigidly attached to the float, which is made of cork.

The most accurate and satisfactory method of testing the course of a hole is to use the compass in a glass tube open at each end and about 6″ long. A section of rubber stopple is forced into the tube, leaving about 1½″ for acid at one end and 4″ for gelatine at the other. A small weighed portion of dry gelatine is carried to the drill and dissolved on the ground in a certain quantity of water, care being taken that the water has no chance to evaporate while dissolving the gelatine. The proportions are so chosen that when dissolved the solution will keep liquid as long as possible after being lowered in the drill hole and yet will become perfectly solid when cold. For instance, using Nelson's Improved Brilliant Gelatine we use 5-6 gram and dissolve it in 50 cc of water. In a hole where the rods can be lowered in twenty minutes or less a 1⅛″ tube is used with paper wrapping. When it takes from twenty to thirty minutes to lower the rods a 1″ tube is used with several wrappings of paper. If deeper than this a thermos bottle is used and by using a paper wrapper the gelatine may thus be kept liquid fifty minutes. The time the gelatine remains liquid was determined by tests in ice-water at 43° Fahrenheit, which is the temperature of the underground water.

In the first two cases when the thermos bottle is not necessary the dissolved gelatine is poured into the tube and heated as hot as possible by immersing the tube in water heated to boiling by live steam. When hot the compass is dropped in and a stopple placed in that end, then about 1″ of dilute hydrofluoric acid is poured into the other end and that end closed. The tube is then wrapped in paper and placed with gelatine end up in the bronze case, which is attached to the bottom of 20′ of brass "E" rods and lowered into the hole, losing as little time as possible. The brass rods are screwed to the bottom of the regular drill rods, an "A" to "E" reducing coupling being used if the hole is being drilled with "A" rods. The bronze case and brass rods are made for an "E" hole so that they can be used in either case. If two tests are to be made at the same time another tube and compass are placed in the case shown in Figure 2 and inserted in the drill rods at the proper point, using 20′ of brass rods on each side.

The tube is left stationary in the hole fifty minutes after the rods are lowered, giving the gelatine time to cool and set and the acid time to etch a good line. It is found that acid diluted with 12 parts of water gives best results. It is diluted in the office and carried to the drill in hard rubber bottles with screw tops, which are much more convenient than the paraffine bottles used at first.

When the tube is brought to surface the positions of the North and South ends of the needle are marked on the glass with a diamond point and the tube washed out and the compass dried to prevent rusting. This tube forms a permanent record of the inclination and course of the hole at the depth where the test was taken.

The thermos bottle is 1⅛″ outside diameter and consists of two clear glass walls with a vacuum between as shown in Figure 5. When it is necessary to use this the hot gelatine and compass are placed in the bottle and the bottle closed by a rubber stopple. The stopple also closes one end of a 1⅛″ tube 3″ long, serving to connect the bottle and tube and preserve them in the same relative position, as shown in Figure 5. Dilute acid is placed in the tube, the other end closed, and the tube and bottle placed in the bronze case and lowered into the drill hole. It only takes the gelatine 1½ hours to solidify in the thermos bottle so that it is usually left in the hole only fifty minutes after the rods reach the bottom, just long enough to get a good etching. It may be left in the hole over night, however, but in that case the acid is diluted more. When the tube is brought to surface the North and South points are marked on it, corresponding to the position of the compass needle in the thermos bottle. The tube then forms a permanent record of course and inclination just as the 6" tube does.

In either case the inclination is read in the goniometer

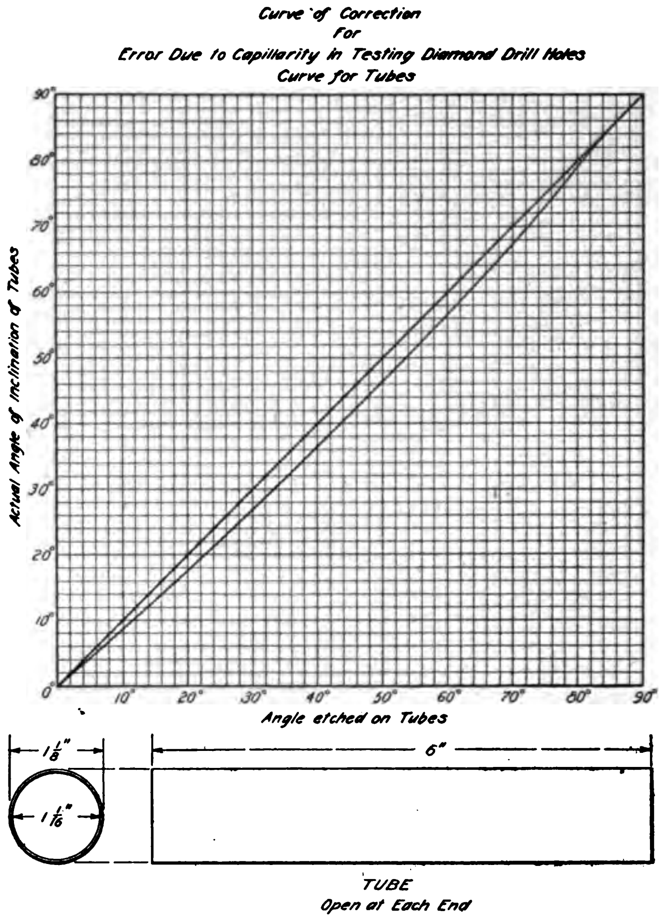


FIG. 4

described and shown by Mr. J. E. Jopling in the Transactions of the Institute for 1909, and is corrected for capillarity according to a curve which is prepared for each size of tube, by testing tubes at known angles according to the method described by Mr. Jopling. Figure 4 shows a curve for

1 1/8″ tubes. It will be noted that for these larger tubes the correction is only 3¾° at 45°, which is the maximum. The angle can be read to ½° and I feel certain that the results of tests for inclination can be relied upon to within 1°.

To determine the course of the hole the tube is placed in the goniometer with the graduated circle set at O° so that the tube is vertical. If the inclination of the hole is steep the tube is twisted until the etching shows the dip to be either directly toward or away from the eye; that is, until the cross-thread bisects the ellipse etched on the glass. If the inclination is shallow it is more accurate to twist the tube so that the dip is to the right or left of the observer and in the plane of the graduated circle. The goniometer is next placed on a protractor so that the tube comes vertically over the center, and by sighting down over a straight edge placed in line with the North and South points marked on the tube the point of the compass towards which the hole dips may be determined. Figures 3 and 5 show tubes with acid, gelatine, compass, and North and South points marked, just as they are taken from the drill hole. I intend to have another goniometer made with horizontal circle to measure the course as well as vertical circle for the inclination, but have not had an opportunity to do so as yet.

We have found the method described above very successful, and two tests at the same point almost always agree. When this is not the case more tests are made and so far we have always been able to ascertain which are wrong. We have made tests at a depth of 2000′, but it would probably be difficult to go much deeper without using more insulating wrapping around the thermos bottle than is possible with a bottle and case of dimensions now used.

The precautions to be taken are three in number: first, that the compass swings perfectly freely, that is, that it does not catch on the cage and that the gelatine keeps liquid long enough; second, that there is no local magnetic attraction in the rock formation; and third, that the compass is not affected by the steel drill rods or casing or by other iron in the hole. The first precaution is easily taken; the second can only be judged by a knowledge of the formation and by taking tests at different depths. If these are concordant there is probably no appreciable magnetic attraction. The third precaution is important. We use 20′ of brass rods and so have no iron within 20′ of the compass. Tests with 10′, 20′, 30′ and 40′ of brass rods at the same depth gave the same reading in a hole dipping 50° North 45° East so that 20′ is conservative. The results of a second test with shorter lengths of brass rods at another point are given below:

Length of Brass Rods.	Inclination.	Apparent Course.
1′	62°	N 6° E
2′		N21°E
3′		N39°E
4′		N35°E
5′		N42°E
6′		N42°E
7′		N41°E
8′		N23°E
10′		N48°E
12′		N50°E
20′		N47°E

SURVEYING IN MAGNETIC FORMATIONS.

When the rock formation is known to be magnetic, or when several tests with the compass do not agree, there seems to be no way of determining the course of a hole but by lowering the rods in such a way that the test tube can be oriented at any point in the hole. We have done this by the method suggested by Mr. Deacon. The rods are first screwed together in one or two long lines on surface just as they will be lowered into the hole, with the bronze case at the end, all the joints being made as tight as usual. Great care is necessary that no twist be left in the rods when screwing them together on the ground. This trouble is not experienced when there is snow as the rods slip easily on the snow and no torsion can be introduced. When the ground is bare it may be avoided by placing level planks at short intervals for the line of rods to rest upon and not allowing them to touch the ground at any point. If not over 500′ in length the rods will turn on grass without leaving any twist in the rods.

When all connected, each joint that is to be broken, usually every second joint, is marked with a chisel so that it can be screwed up again to exactly the same place. They are marked exactly on top as they lie on the ground so that when the rods are in the hole the marks will point in exactly the same direction. The joints are then broken, being careful not to disturb any joints which are not marked.

Dilute hydrofluoric acid is poured into a glass tube and the tube marked with a diamond and placed in the bronze case so that the mark on the tube corresponds with that on the case. The tube is then lowered into the hole, being careful to exactly match the marks at every joint. The mark on the last rod is placed directly in front of the drill and this direction determined, which is the direction of the mark on the glass tube. The tube is left stationary at the bottom of the hole for about fifty minutes when acid diluted 12 to 1 is used and then withdrawn and washed. To determine the course of the hole another mark is made exactly on the opposite side of the tube and the course found by using the goniometer and protractor as described in connection with the gelatine test.

This method of course only gives accurate results when the rods turn easily in the hole so that there is no twist in the rods when lowered. This is usually the case except in very deep holes or in holes where the inclination is low or where the curvature is excessive. In these cases, unless the hole is rifled, the twist may probably be removed by raising and lowering the rods several feet a few times after the rods are in the hole. Precaution should be taken that the tube cannot turn in the bronze case, either by wrapping with paper or by using a stopple which fits the case snugly. Our tests by this method do not always agree and are apt to be 10° or 20° anti-clockwise from the course as determined by compass in a non-magnetic formation. One reason for this seems to be that in lowering the rods the joints work tight or loose because of the friction of the rods revolving in the hole.

The Cleveland-Cliffs Iron Company
Ishpeming, Michigan
RECORD OF DIAMOND DRILLING

..........................SHIFT ....191....

Where Working...
Section.. Hole No.............

	Feet	Core Saved	Hours
Total depth of hole per last report.........	....		
Moving and setting up.....................			....
Drove..........inch stand pipe............	....		....
Drilled with chopping bit..................	....		....
Drilled with diamonds.......................	....	....	....
Reamed from............to...........ft.	....		....
Lowered..........inch casing to........ft.	....		....
Total Depth of Hole............	....		
Kind of Material..........................	....	....	....
....	....	....	....

	Feet	Size	Hours
Bit No..................................	....	....	....
Bit No..................................	....	....	....
Bit No..................................	....	....	....
Number of Men........................			....

Remarks...
....

....Runner
....Helper
....Setter
Report delays, accidents, etc. ....Foreman

FIG. 6

District...
Sec..................................Hole No..............................
Depth..

FIG. 7

DAILY REPORTS.

Figure 6 shows a report form filled out by the drillmen every shift for the drill foreman and the head office, and Figure 7 a sample tag which is placed in every bag of core or sludge. The record of time of drilling and footage of each diamond bit is kept to obtain data on the several stones in the bit with the idea of determining which are the most economical. These tests have shown that the wearing quality of the stone depends considerably upon the specific gravity and upon the structure.

Although it is important to have the drillmen report the amount of core saved from each material, yet they rarely measure it accurately and if the analyses of core and sludge are to be combined as described below the core is remeasured when it reaches the office.

SAMPLES FROM DRILL HOLES.

The following directions for saving samples are posted in the drill shanties and enforced by the inspector.

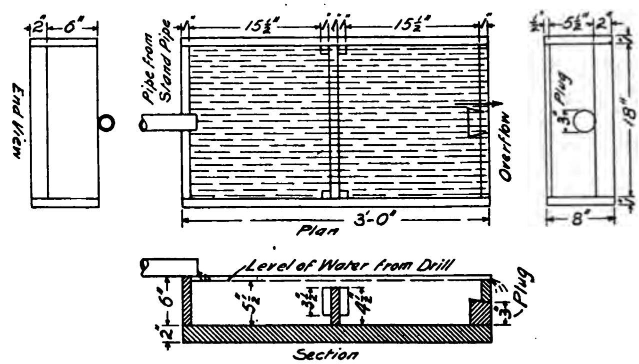


FIG. 8

DIRECTIONS FOR SAVING SLUDGE FROM DIAMOND DRILL HOLES.

"Set the standard sludge box just below the floor of the shanty and in such position that there is room to siphon off the water and take out the sample without moving the box. Connect a tee to the top of the standpipe or casing and lead a pipe from it to the nearer end of the sludge box, at such a height that it will either be level or slant towards the sludge box and just rest upon the top of the box, and of such a length that it will not project more than one inch beyond the edge of the box. The pipe must not be more than two feet long, and if longer than one foot must be split on top for the foot nearest the sludge box, so that if sludge collects in the pipe it may be seen. Set the box level so that water will overflow evenly across the whole width at the far end and wedge the partition firmly so that it is in close contact with the bottom of the box. The top of the partition should be one inch below the water level. The box is now ready to receive the sample and drilling may be started.

While drilling, care must be taken that no water from the drill hole escapes around or over the tee except through the pipe leading to the sludge box. Care must also be taken that there is no leak from the box and that the three inch plug at the end of the box is tight. Sludge samples must be taken for every five feet drilled or less, preferably from even five foot intervals; that is, from 460 to 465, 465 to 470, 470 to 475, etc.

Whenever a sludge sample is to be taken drilling must be stopped and the hole washed out clean. The pipe leading to the sludge box must be cleaned out into the sludge box and either the pump must then be stopped or the tee turned so that the water will not be discharged into the box. Carefully remove the partition in the box so as not to stir up the sludge any more than necessary and when the sludge is settled siphon off the surplus water, being careful to keep the end of the siphon near the surface of the water and not disturb or draw off any of the fine sludge at the bottom of the box. To use the siphon, fill with water a three foot length of large size flexible hose and with one hand on each end place one end beneath the surface of the water in the box and the other end on the ground eight inches or more below the top of the box. When both ends of the hose are released the water will flow out of the box and may be allowed to flow until it is seen that the sludge is beginning to go off with the water. Then remove the hose and thoroughly mix the sludge in the box to a mud. This must all be removed from the box and placed in a pan on the boiler to dry. The pan must be at least 8"x12"x1" deep, with flat bottom, and must be thoroughly cleaned each time before a sample is put in it to dry. If enough water cannot be drawn off without disturbing the sludge so that the sample can be contained in this pan, a larger pan must be used. All the sludge must be saved and the sludge box cleaned thoroughly. When the sludge has been cleaned out, remove the three inch plug at the end of the box and wash out the box with a pail or two of water, then replace the plug and partition and drilling may be started again. The sludge must be labeled, giving the depths between which the sample was taken, when it is placed on the boiler to dry. It must all be saved and turned over to the inspector. Sludge must always be saved when drilling in iron formation or in any other ferruginous or red material. While drilling in material from which a sludge sample should be saved, if the water is lost, if the sludge does not come up with the water, or if the sludge is contaminated with material caving from higher up in the hole, drilling must be stopped immediately until the hole is put in such condition that good sludge samples can again be obtained, or until the inspector gives orders that drilling may proceed.

Whenever the drill runs into or out of ore, provided the band of ore or rock is one foot or more thick, drilling must be stopped and the sludge box cleaned out immediately, without waiting to complete the five foot run. When the drill runs out of ore continue taking and saving sludge samples for at least twenty feet, no matter what the material, so that it may be determined whether the ore is caving.

Keep the core separate from the sludge and each time core is pulled label it with the depths between which it was recovered. Each run of core must be kept separate and all core must be saved and turned over to the inspector. When the core is pulled if it is found that more core is saved than the proportion of one foot of core to ten feet of drilling, the sludge box must be cleaned without waiting to complete the five foot run, and the sludge labeled and saved separately. If sludge from a shorter distance than five feet is in the box at the end of the shift's work, and if less than the above proportion of core is saved, the sludge may be left in the box provided the shanty is locked and the box is inaccessible from outside the shanty. If anybody can get at the box, however, and if there is no watchman, the sludge must be removed from the box, dried, labeled and placed with the other samples."

The standard sludge box is shown in Figure 8.

When the samples reach the office they are carefully examined and a daily report of all drilling made out on the form shown in Figure 9. Samples of all core and of all

THE CLEVELAND-CLIFFS IRON CO.

DAILY REPORT OF DIAMOMD DRILLS

Ishpeming, Mich.,.........................191....

Section	Hole No.	Date	Feet Drilled	Total Depth	Material	Remarks

FIG. 9

sludge which runs above 40% iron are preserved in a room and in cabinets designed especially for the purpose. A few pieces of core are saved from every run and the rest sent to the laboratory for analysis if ore formation, or thrown away if not. A little of each sludge sample is placed in a small pasteboard tray with a temporary label, 10′ to a tray, until the analysis is completed. Each 10′ of sludge sample which runs over 40% is then placed in a gelatine case and preserved in the same drawer with the core. Gummed paper labels are used for both core and sludge and the samples preserved in the drawers shown in Figure 10.

INTERPRETATION OF ANALYSES.

Mr. W. J. Mead has described our method of combining core and sludge analyses in an article in the Engineering & Mining Journal of May 6th, 1911, except that we used a formula in the method which I described to Mr. Mead several months ago instead of the diagram which he has de-

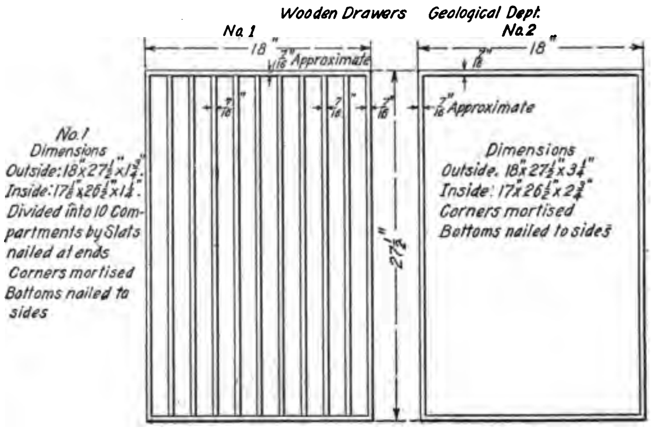


FIG. 10

veloped from it. Since other engineers may also be interested in the formula I give the derivation below:

Let A = diameter of bit outside of carbon.
" B = diameter of bit inside of carbon.
" C = feet of core saved in "D" feet drilled.
" D = feet drilled.
" S = volume of rock actually ground to sludge.
" T = volume of rock actually saved as core.
" T = 3.1416.

$$\text{Then } S = D\left(\frac{TA^2}{4} - \frac{TB^2}{4}\right) + (D-C)\frac{TB^2}{4}$$

$$\text{and } T = C\,\frac{TB^2}{4}$$

$$\text{Hence } \frac{S}{T} = \frac{D(A^2 - B^2) + (D-C)B^2}{CB^2} = \frac{DA^2}{CB^2} - 1$$

	Dimensions of Bits Inside of Carbon	Outside of Carbon
Standard "A" bit	1"	1 13-16"
" "E" bit	27-32"	1 9-16"

$$\text{Hence for an "A" bit } \frac{S}{T} = \frac{1.813^2\,D}{C} - 1 = 3.29\,\frac{D}{C} - 1$$

$$\text{and for an "E" bit } \frac{S}{T} = \frac{1.563^2\,D}{.844^2\,C} - 1 = 3.43\,\frac{D}{C} - 1$$

To obtain an average of the sludge and core analyses giving the proper weight to each, the sludge analysis should evidently be multiplied by "S" and the core analysis by "T" and the sum of the products divided by S + T. The result is the same and the operation simpler to multiply the sludge by $\frac{S}{T}$ and the core by 1 and divide by $\frac{S}{T} + 1$; hence the rule for an "A" bit is to multiply the sludge analysis by $3.3\frac{D}{O}-1$, add the core analysis, and divide the sum by $3.3\frac{D}{O}$ Since the core is rarely pulled in five foot runs we find it just as simple to figure the ratio from the formula as from Mr. Mead's diagram.

Mr. Mead did not mention the method of obtaining the average analysis which he formerly used, namely, to weigh out proportionate parts of core and sludge and combine them for analysis. This method is ingenious but is open to objections: first, if it is found later that the hole was caving and the sludge of no value the core analysis is also rendered valueless; second, in order to get true analyses it is advisable to send the whole sample for analysis except a small portion kept for record, whereas if weighed out a portion must be rejected.

We only run iron on the five foot samples, with phosphorus if over 40% iron, and manganese if there may be over 1% or 2%. We occasionally combine several of the five foot sludge samples and make a complete analysis for iron, phosphorus, silica, lime, magnesia, alumina, manganese, sulphur, titanium and loss by ignition.

After combining the core and sludge analyses the results are further averaged in continuous runs of ore of the same grade. We call from 45% to 50% iron lean ore, 50% to 57% second class ore and above 57% first class ore.

REPRESENTATION OF RESULTS.

As soon as possible after the first of the month the record of material drilled through the previous month is compiled from daily reports and averaged analyses. This is carefully checked over with the core and then recorded permanently

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RECORD OF DIAMOND DRILLING

Hole No........
Sheet No.......

District }
Mine } State................T...........R............Sec............Hole No............Location:...... ....
Dip:......................... ..Course:...........................Drilled by whom........................with.........................

	Date	No. Hours	CORE RECOVERED Ft.	In.	Stand Pipe	Drilled	Total Depth	Kind of Material	Begins at	Dip of Strata	Remarks

FIG. 11

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ANALYSIS OF CUTTINGS AND CORE

District } ....
Mine } ....
Option } .... State..........T..........R.... .....Sec..........Hole No............Location..............................
Lease } .... Determined by................................ 191.... Elevation of Collar.......................

	From	To	Iron	Phos.												

FIG. 12

in the drill book. This is a loose-leaf book with pages shown in Figures 11 and 12. The reports of the drillmen and analyses of samples are copied in this book daily and it forms the complete and permanent record of drilling. From this book tracings are plotted which are blue printed for the various parties entitled to receive the information. Figures 13 and 14 show the printed forms on tracing cloth used for this purpose. They are 14"x16", the same size as the loose-leaf sheets in the drill book, and are bound in covers of the same size.

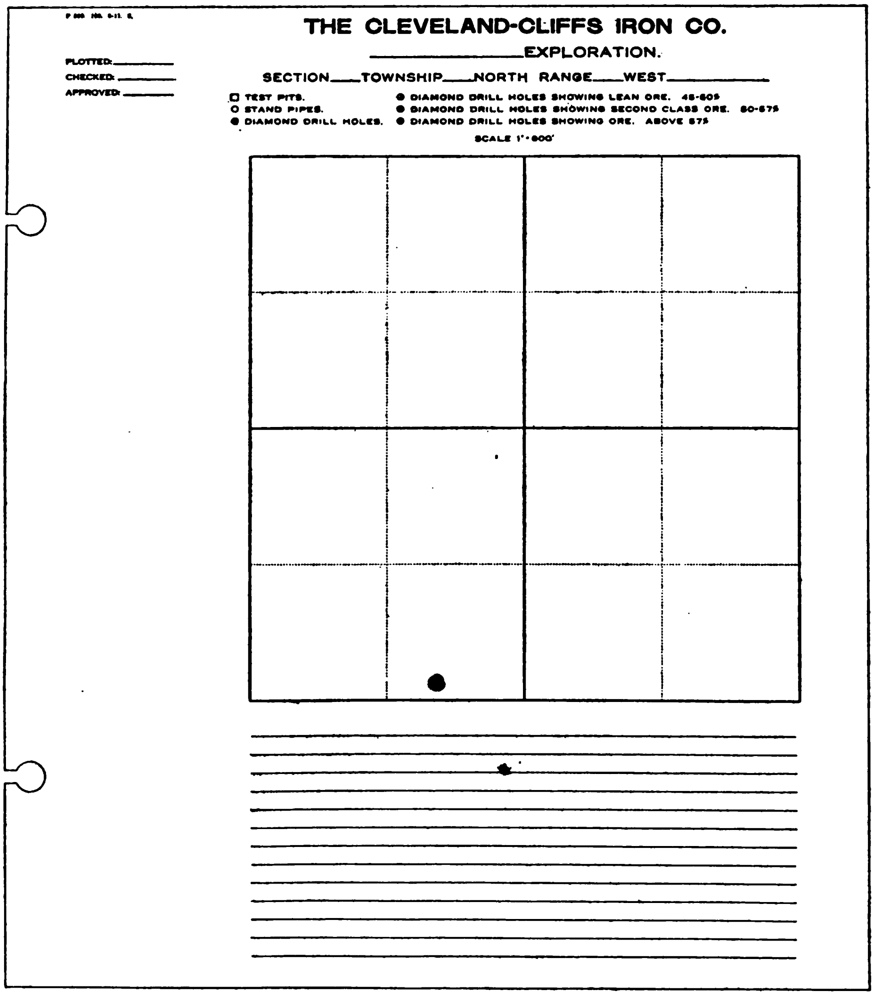
CROSS-SECTIONS OF DRILLING.

For scientific location of drill holes cross-sections must be made through previous drill holes, preferably at right angles to the strike of the formation, showing the holes plotted according to the surveys for inclination and course, and showing the material encountered. We make these on cross-section tracing cloth ruled in inches and tenths, on a scale of 50' to the inch. The sections may be superposed and compared, and the cross-section ruling makes it easy to read distances and areas without a scale. On these tracings the geological boundaries of formations and the outlines of ore bodies are drawn in soft pencil, which prints satisfactorily but may easily be erased and changed if further drilling shows the first assumptions to be wrong. When necessary longitudinal sections are made and taken in connection with a plan and cross-sections give a very good idea of the structure.

DEFLECTIONS OF DRILL HOLES.

In an article written for the South African Mining Journal of June 11th, 1910 and again in an article in the same journal of March, 1911, Mr. J. S. Curtis gives an interesting theory of the cause of bore hole deflections with results of experiments which he made to substantiate his theory. He endeavors to show that the influence of terrestrial magnetism should cause vertical drill holes to deviate to the North in the Southern Hemisphere and states that this is the case in the great majority of holes, although the direction may be changed by the character of the country rock.

In our experience the latter feature is much the more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__________EXPLORATION.

PLOTTED: ________

CHECKED: ________

APPROVED: ________

SECTION___TOWNSHIP___NORTH RANGE___WEST__________

□ TEST PITS. ● DIAMOND DRILL HOLES SHOWING LEAN ORE. 45-50%

○ STAND PIPES. ● DIAMOND DRILL HOLES SHOWING SECOND CLASS ORE. 50-57%

● DIAMOND DRILL HOLES. ● DIAMOND DRILL HOLES SHOWING ORE. ABOVE 57%

SCALE 1"=800'

FIG. 13

important and from results of our drilling I should not say that the great majority of drill holes deviate either North or South in all districts. If the strata are flat and uniform the holes may do so but if the strata dip steeply this is not the case. In one district where the dip is steep we are certain of the course of 14 holes which deviated from the vertical and these are shown in Figure 15. Of these holes one went approximately North, one approximately South, one Northeast, five Northwest, one Southeast and five Southwest. Put-

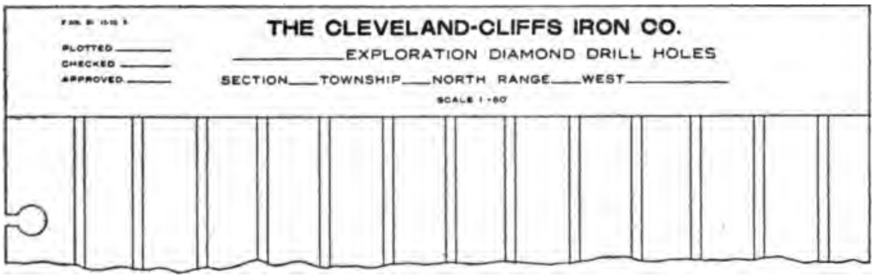


FIG. 14

ting it in another way seven deviated to the North and seven to the South, while two deviated to the East and ten to the West. If these results show anything they only show that the

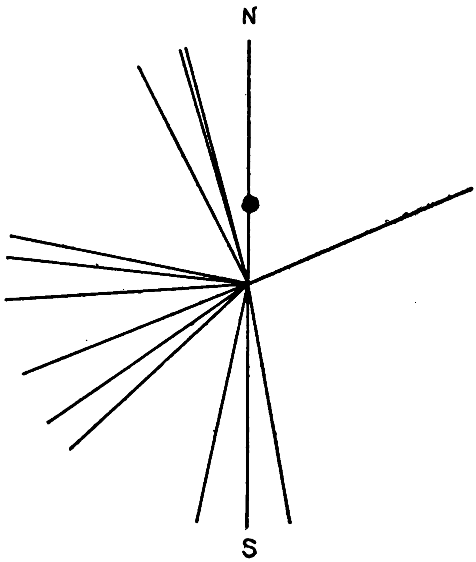


FIG. 15

majority of the holes deviated to the West, but equally to the Northwest and Southwest.

It is very difficult to keep vertical diamond drill holes straight and I believe that a hole can be located with more assurance of striking a certain point in depth if it is given an inclination of 85° against a steeply dipping formation than if it is started vertical. We have only drilled two holes with this inclination, with results as follows:

Depth.	No. 1.	No. 2.
At surface	85°	85½°
At ledge	86°	86½°
200′	86°	
400′	85°	87¾°
500′	87½°	
600′	87°	
800′		88½°
1200′		85½°

These two holes are not enough to generalize upon but they certainly kept straighter than vertical holes in the same district. In addition to that we knew in which direction the holes were going, which we do not know when we start a vertical hole. In my article in the Engineering & Mining Journal of September 17th, 1910, I gave a series of curves showing the curvature to be expected in an inclined hole when dipping against a steep jasper formation. I would change the curve for a hole started at 85°, as that seems to be a critical angle under these conditions and the hole does not flatten as would be expected.

In view of the sometimes surprising curvature of drill holes I feel that all holes should be tested for both course and inclination at 100 ft. or 200 ft. intervals, whether started vertical or an an angle, otherwise there is no telling where the ore or other strata cut really occur. We recently started a vertical hole which at a depth of 800 ft. was found to have an inclination of only 51° from the horizontal. Another hole started at an angle N54°W was found to be running N64°E at the bottom.

SOCIAL SURROUNDINGS OF THE MINE EMPLOYE.

BY CHARLES E. LAWRENCE, IRON MOUNTAIN, MICH.

In this period of time the magazines and newspapers call our attention to "Progress in Peace." One of the historical events of the movement is the recent treaty of the Empire of Great Britain and the United States of America, including France, signed by President Taft and the ambassadors of these nations. As the United States leads in the art of peace in contrast to war, as it effects nations at large, I call your respectful attention to the advancing of the peaceful welfare of the mine employes, in comparison to former careless and indifferent treatment.

These local conditions are passing through an experimental stage, and only the future period of time can determine the correctness of this mode of action. The mining territory of the Lake Superior district is composed of a large European population, coming from all countries, who have only their labor to give, lacking in personal wealth, or educational refinement, to make their lives pleasant and peaceful, or in other words, leading a hard pioneer life. With this view the present laws of labor, society and governments begin to change these foreigner's lives and make American citizens. The laws of personal freedom, exercised here under pioneer conditions, are misused, and misjudged, and make for abuses, largely through ignorance, and demand constant vigilance, supervision and care on the part of all good Americans, to guide these foreigners in the right channels of thought and action, toward each other.

In the proper consideration of this broad civic duty, and its many relations, we come to its bearing as to mining. The labor cost is usually the greatest charge in products, and applied to mining, from two-thirds (2-3) to three-fourths (3-4) is a probable rate. We, therefore, should give to it the most consideration. We have, in the operation of mining: First, experts in the securing or winning of the mineral in the ground, represented by our mining captains; second, experts of machinery; third, experts in geology; and fourth, expert secretaries and auditors. But can we say truly that we have experts for the handling, care and study of labor? I think you will all agree with me that it is the one item which has been seriously neglected.

AM I MY BROTHER'S KEEPER?

Yes! When it is a serious financial question of two-thirds of the cost of mining ore in the district.

Yes! When you consider it financially, morally or from a broad civic view, as this is the object of government.

Labor, which is another name for the man, who must first take care of himself in dangerous places of mine operation; who must handle tools and machinery properly, who must do it ten hours on the job and keep it up for three hundred days of the year, and for several years. Labor is the man from Europe, be he Finn, Swede, German, Russian, Austrian or Italian.

Labor, under this consideration, primarily answered is "That I am my brother's keeper," will assist materially to aid us in the mining of ore, cheaper, easier, pleasanter, and help rob the vocation of mining of its danger or fear and instilling a contrasting satisfaction of safety and relief of anxious care.

HOW SHALL WE BEGIN?

First. In having every kind of safety device, as applied to mining and machinery, with a competent surgeon and a trained corp of employes to act as first aid to the injured.

Second. In not allowing men to work two or three shifts continuously and without rest, which over-taxes their physical strength, also, to have a true knowledge of mine conditions.

Third. By compulsory accident funds and pension systems.

Fourth. By providing good sanitary houses and surroundings, with a social center typified by a club house.

By going into detail classification of these four general divisions, we find:

First. Safety devices. The last few years a deluge of valuable ideas have been put in vogue as regards machinery, and the application of the same to the working parts, to save accidents and injury. In mining it is not so easy. The safety committee, composed of from three to five employes of average intelligence, at each mine, could easily criticise all dangerous places, and have them properly fixed to save injury. Their report of criticism could be gone over by a meeting of bosses and employes, say once a month, and in this way, spread the general information of "Safety First," which makes a vital, live subject in which each and all are interested. This spirit prevailing through the whole force of employes will save many injuries, due to general neglect or oversight, and help to make an amicable relation between nationalities where friction exists. Safety signs could be put up to call attention, and renewed from time to time by changing the colors of placard. The surgeon plays a big role in the safety program. He could organize a class of employes who could render first aid to the injured, and who are constantly on the job, and supplied with splints for broken limbs, and a galvanized box containing sanitary antiseptic bandages. The money so spent is returned in many ways, by consistent care and interest, as a humane proposition, also in keeping in good shape the tools and equipment for use around the mine, following closely all suggestions of the safety committee.

Second. Next to railroading, statistics classify mining as producing the greatest number of fatal accidents. As we stop and ponder why, we conclude (1) that a large number of men go down in the dark drifts and stopes who are young, without judgment and knowledge, lacking a proper understanding of the English language, in orders given by the mining capitain or his assistants, (2) careless fellow workers and partners, (3) lack of sufficient light to see how to perform the necessary work, (4) poor tools or dangerous conditions in working places, left so by the employes on the previous shift, (5) lack of knowledge of explosives, (6) long hours in bad air, and numerous other causes, all of which end fatally, and give to mining a careless indifference which is not seen in time to overcome, in the judgment used by green and ignorant employes, who take the risks in order to secure the higher wages for duties which they are not fitted to perform.

To avoid all this, the mining captain should have a man constantly to study the employes, in their different nationalities, to round out the many sided phases presenting, and build up an organization to overcome the dangers constantly coming up by the new and changing conditions on each level.

Third. Every mine should be compelled to have an accident fund and a pension system. The vocation of mining will always be dangerous. Employes should contribute a part of their wages to the care of an accident fund and receive in this manner back an insurance fund, to help pay for the loss of time. Likewise, as the exhausting and arduous work shortens their lives, a pension system would sweeten and make pleasant old age, all of which could be systematically handled.

Fourth. Social surroundings. Wages being approximately equal, men will leave a property where there is an old or poor dry house, and go to a mine where there is one up-to-date, being supplied with proper washing facilities, such as cold and warm water, shower baths and tubs, including individual lockers and sanitary arrangement to keep clean.

This humane phase, considered in its broad view, applies to the company houses, which can be kept clean and neat inside by a fresh coat of white wash or calsomine, once a year, and a coat of paint outside, and should also be supplied with fresh water and a small garden, with growing trees to make it look like a home. To encourage this latter idea and start it for a few years, prizes could be given for the best vegetable or flower gardens, also a small expenditure made in free seeds, to get the movement properly started.

With up-to-date schools, a church and a social center at which to congregate, such as a club house, it rounds out a complete whole in the lives of employes, around a mine. This latter may seem a luxury, but a club house, put up by the mining company, containing shower and tub baths, bowling alley, card tables, billiard and pool tables, combined with a reading room having various magazines and newspapers, with a pianola and graphophone, will take people out of the four wall of their homes at occasional times, and change their thoughts and form a silver lining to the clouds of their daily labor, done under dark and dirty conditions. This club house, kept always clean and cheerful, and used by wives one day of the week, also permission given to growing boys and girls on Sundays, has, in at least one case, proven of such value that the mining company are putting up a second one, at another of their properties.

The officer of the company whose duty it will be in the future to look after the men, could arrange with entertainment companies, such as colored minstrels, popular lecturers and singers, combined with moving picture or stereopticon shows, these to be interspersed to suit local conditions. This officer could conduct a night school which is a great demand at all mines by the foreigner who is anxious to read and write the English language. Last, but not least, a sympathetic nurse should be kept around a mine to assist in family sickness.

This whole subject simmers down to mutual and amicable relations of mine employes and the securing of same. The suggestions offered seem warranted and demanded, first, because of financial returns and second on civic humane grounds, also to change the small distorted ideas of the foreign laborer towards his employer to one of mutual respect and confidence, all of which will give a cheaper cost in the ore produced, due to the amount of two-thirds or three-fourths entering same.

"All work and no play makes Jack a dull boy," unless mine operators change the rut they have been running in for the past years. This can be accomplished on a joint basis more satisfactorily than is done singly.

Labor, sandwiched with some pleasant variations, is the ideal goal for all mankind.

Following statistics have been prepared by the officers of the Baltic Mine club, showing attendance from January 1st, 1909, to August 31st, 1911:

1909—	Total Attendance.	Average Daily Attendance.	Total Baths.	Average Daily Baths.
January	2,725	88	281	9
February	2,135	76	361	13
March	2,175	72	281	9
April	2,175	72	281	9
May	1,863	60	340	11
June	1,639	55	353	12
July	1,639	55	353	12
August	1,758	57	388	13
September	1,645	55	292	9
October	1,635	53	241	8
November	1,882	63	185	7
December	1,745	56	192	6
Average for year	23,016	63	3,548	10
1910—				
January	1,219	68	270	9
February	2,436	87	213	8
March	2,305	74	296	11
April	2,020	67	240	8
May	1,480	48	289	9
June	1,558	52	320	11
July	1,590	51	309	10
August	1,620	52	367	12
September	1,568	52	186	6
October	1,530	50	249	8
November	1,830	61	160	5
December	1,805	59	125	4
Average for year	20,961	59	3,024	9
1911—				
January	2,680	86	180	6
February	2,355	84	226	8
March	2,131	70	172	6
April	1,940	64	275	9
May	1,880	61	300	10
June	1,235	42	224	8
July	1,130	36	174	6
August	1,220	41	160	5
Av. for 8 months	14,571	60	1,711	8

TIMEKEEPING SYSTEM AND LABOR DISTRIBUTION AT THE NEWPORT MINE.

BY G. L. OLSON, IRONWOOD, MICH.

There has been installed at the Newport Mining Company, a system of keeping time and labor distribution, which might be termed, "In and Out clock check system," with additional check made by actual observation of men while at work by field timekeeper and underground clerks, and it is the intention in this paper to outline briefly the methods used to obtain and collate all data in connection with the labor roll and distribution of labor charges.

Both labor roll and distribution are assembled in what may be termed a cumulative roll, that is, on the labor roll the earnings of each man, each day, are added to his earnings for the previous day comprising the pay period, so that at any time we are able to see at a glance exactly what amount any or all employees have earned to date, and in a like manner by referring to distribution summaries, the total amounts chargeable to any particular item for the period to date may be ascertained. This feature of cumulative figures might be thought, at first, very complicated and unwieldy, but experience has taught us that the operation is both simple and speedy. By availing ourselves of the various mechanical appliances now in use in all modern offices, such as time stamps, adding machines, addressographs, etc., all electrically operated, we have been able to reduce our expense in connection with the time department, and also remove to a very large degree the "human element" which is always an undesirable factor where actual time records are desired. In connection with speed attained by the use of these mechanical appliances and method of accumulative roll and distribution, we believe you will agree with us that the desired result is obtained when we state that at the Newport Mine the Time department is able to send to the General office the complete pay roll, checked and audited, and distribution of same (covering under normal conditions approximately 1,500 employes and 500 distribution accounts) eight hours after the completion of a month's operations. This is on account of showing the complete roll to date and balancing cumulative distribution of same each day as the month's work progresses, so that at the end of the period there is no necessity for making the extensions for the whole month on each individual, and large loss of time in endeavoring to balance a month's figures as obtained by the pay roll against the distribution charges to the various items comprised in the card of accounts. As a matter of fact, the ending of a month at the Newport has none of the usual terrors for the time and accounting departments which are so common at plants where the old systems are in vogue, the operation being almost exactly the same as any other day of the period, no extra work or overtime by the department being necessary.

We have also endeavored to arrange all blanks used in the time department so that the information placed on same by field timekeeper, underground clerks and foremen will be exact and give no confusion whatsoever when collected and recorded in the time office. Our pay roll and distribution sheets are ruled so that they will fit and tabulate on mechanical devices exactly.

We were fortunate at the Newport to have had this system of "In and Out checking" installed and perfected before building our new timekeeping office, and were able to arrange same so that the handling of checks and time cards to the men at the start and completion of the day's work is greatly facilitated by the arrangement of checking windows, alleyways, etc., and, if necessary, we are able to check men in or out at four different windows or bays, handling at the rate of approximately seventy-five men per minute. (See drawing of Captain's and Timekeeper's office, showing layout of checking windows, racks, alleyways, etc.) The equipment in the timekeeping department consists of the following: check and time card racks, same being interchangeable. That is, when checking the men in we have the time card racks in place, and when checking out, the brass check racks are in place. The brass check racks each hold 500 brass checks, and the time card racks each hold 250. In addition to this equipment, we have a time card filling bus which is divided into compartments and numbered, each compartment holding one month's supply of time cards. The time cards are filed daily in this bus and held there until the end of the month.

All men must come to the Timekeeper's Office before going to work (the underground men to be in their underground clothes) and present their brass checks at the window and receive, in turn, a time card (Form 89-C) on which the time that the employe checks in is stamped with electric time stamp. This card bears the man's name, occupation, and pay roll number, (number in large type), all of which information is printed by the Addressograph. As a general rule a weekly supply of these cards is printed and racked on card racks which are placed near the check window. The card provides for the insertion of the hours worked, rate, hours allowed and reasons, if change has been made, amount earned, contract number, distribution, and for the signature of the underground clerk. It also provides for the signature of foreman or captain as voucher for the extra time allowed.

All underground men carry these cards until seen by the underground clerk, who inserts the distribution, hours worked, rate, amount earned, contract number on the miners cards, and signs same, taking up the cards at each place of operation and giving them to the foreman in charge. The foreman in charge of each particular gang retains the cards until the end of the shift, at which time he stations himself near the shaft and returns them to the men. In this way the foreman is aware that all of his men have gone to the shaft. Owing to the inability of our underground clerks to make more than one trip per turn, on account of the large territory they cover, all underground time cards are marked with the number of hours constituting a shift. Should an underground man go to surface before the end of the shift, he must go to his

N. M. Co. Time Card

In.......... ....

1508

Geo. Bratel Miner

Hours Allowed...... Rate.......

Hours Worked.....Reason.....

Amount Earned..............

Contract No...................

DISTRIBUTION

Acc't No.	Class	Hrs.	Amount	
TOTAL				

Time Allowed O. K .. ..
Captain

Signed.........................
Clerk

Out.........................

Form 89C

N. M. Co.

MINERS BONUS CARD

1470

Jno. Madyoin Miner

Amount Bonus..................

Company Account Rate........

Days		Rate	Amount		Contract No.

Month Ending.................

Form 117C

foreman who re-marks the card as to actual hours worked and the employe then goes to the 15th level where a record is kept by the station man showing the man's number and the time that he goes to surface. These reports are furnished the chief timekeeper that he may verify the time appearing on the card. In this way no employe can go to surface before quitting time and not check out immediately and still receive full time. In addition to the underground clerk's duties of marking time cards, they assist the foremen in ordering supplies and also relieve them of as much clerical work as possible in order to allow them a greater amount of time for supervision, inspection, etc.

The surface cards are marked in a like manner, except for mechanical department, teamsters, and surface laborers, on whose cards the distribution is not shown for the reason that their time, being more or less divided, is taken care of by distribution tickets rendered by the foreman or clerk of the various shops. See forms 97-98-99-C. (White shop ticket for construction and red for ordinary repairs). The surface cards are marked on the second, or afternoon trip, of the surface timekeeper, the cards not being picked up and given to the foremen, but returned to the men.

At the end of the shift all men must exchange time cards at check windows for their brass checks (the underground men in underground clothes). These cards are then stamped with the out time by the electric time stamp, in the same manner as checking in. In addition to the surface time keeper and underground clerks marking the time cards, a record is kept by them in a time book showing the man's name, number, occupation, time worked, and carried under the various places of operation. This time book serves as the mine record and whenever an employe leaves the service of the company, a notation is made in this book and the reason therefor. This time book is filed and is an easily accessible guide, in addition to the daily time card, for the settling of any questions that might arise regarding an employe. In order to be absolutely certain that all men check out, an inventory of the brass check board is taken in the morning and evening and any checks remaining after a shift is accounted for by inquiries made of the foreman by the timekeeper. The explanation for these checks remaining on the board is inserted on a regular form (CI-178) kept in the timekeeper's office and thus furnishes information to captains or others interested as to reason of employe not checking out at the usual time.

Shop Order No.________ **NEWPORT MINING CO.** REPAIRS

NEWPORT MINE Account No. ________

________ Shop WORK TICKET Date ________ 19

Pay Roll No.	Description of Work	Dept.	Hours	Rate	Amount

Time Started ________

Time Completed ________ ________ Foreman

Form 97C—Red—(Reduced)

Shop Order No.________ **NEWPORT MINING CO.** CONSTRUCTION

NEWPORT MINE Account No. ________

________ Shop WORK TICKET Date ________ 19

Pay Roll No.	Description of Work	Dept.	Time	Amonnt

Time Started ________

Time Completed ________ ________ Foreman

Form 98C—White—(Reduced)

________ **NEWPORT MINING CO.** Account No. ________

Dis. of Surface Time NEWPORT MINE Date ________ 19

Pay Roll No.	Description of Work	Dept.	Hours	Amount

Form 99C—(Reduced) ________ Foreman

The next step is the method of getting and handling distribution. As explained above, all distribution for mechanical department, teamsters, and surface laborers, is reported by tickets. These tickets give a full description of the work, pay roll number of the man who did the work, rate, and also on the shop tickets the shop in which the work was performed. The tickets are sent to the timekeepers' office at the end of each shift and extended and checked against the above enumerated departments.

After getting the distribution of the mechanical men, the time cards for all others are arranged according to the card

NEWPORT MINING COMPANY

NEWPORT MINE

Record of Brass Checks in Check Boards

Ironwood, Mich.,__________________191

7:00 A. M.		7:00 P. M.		3:00 P. M. to 10:00 P. M.	
Check No.	Reason for Check in Board	Check No.	Reason for Check in Board	Check No.	Reason for Check in Board

Form CI-178—(Reduced)

of accounts and entered on a working sheet, (Form CI-48), for the purpose of assembling all charges against each account. Instead of entering the total amount under each sub-division, the days and rates are entered. This form (CI-48) is also used in compiling the daily summary of men employed (CI-17) which will be mentioned later. When these are extended, the total of the distribution should agree with the total of the time cards. From the working sheet the distribution shown thereon is posted to the regular distribution sheets which carry the accumulative total against each account.

Daily Total - -		
Previous Total -		
To Date Total -		

Date.....................................

Sheet No.............................

LABOR DISTRIBUTION

Account	Days.	Hrs.	Rate	Amount	Total Amount	Account	Days.	Hrs.	Rate	Amount	Total Amount	Account	Days.	Hrs.	Rate	Amount	Total Amount

Form CI-48 (Reduced) (Sheets arranged for loose leaf binder.)

THE NEWPORT MINING COMPANY

Daily Summary Men Employed ....191 .....

LOCATION: SURFACE	LOCATION: UNDERGROUND	D SHAFT: Ore	Total	D SHAFT: Rock	Total	D SHAFT: Main Levels	Total	Total D	K Shaft	Total K	Grand Total
Mgr., Supt. and Mach. Eng.	Capts. and Assts.	Under this head there is space for 13 columns		Under this head is space for 5 columns		Under this head is space for 6 columns			Under this head is space for 12 columns		
Acct., Clerks and Timekrs.	Shift Foremen										
Safety Insp'ct'r and Interp.	Trammer Foremen										
Mining Engin'r and Assts.	Clerks										
Chief Chemist and Assts.	Timb. Forem'n & Assts.										
Samplers	Timber Miners										
Grinders	Timber Trammers										
Watchmen	Skiproad Inspectors										
Janitors	Shaft Repair Foreman										
Stablemen	Shaft Repair Men										
Surface Foremen & Assts.	Skip Tenders										
Lander Foremen	Chute Tenders										
Ore Landers	Motormen										
Timber Landers	Swampers										
Dry Tenders	Dumpers										
Timber Unloaders	Car Repair										
Timber Framers	Track Foremen										
Teamsters	Trackmen										
Surface Laborers	Track Cleaners										
Motormen	Door Boys										
Puffermen	Bell Boys										
Rope Inspectors	Switch Tenders										
Master Mechanics	Powdermen										
Machinists and Helpers	Car Oilers										
Pipe Foreman	Water Boys										
Pipe Fitters	Pumpmen										
Carpenter Foremen	Pipe Fitters										
Carpenters and Helpers	Fire Patrolmen										
Blacksmith Foreman	Pump Foreman										
Blacksmiths and Helpers	Puffermen										
Chief Electrician	Ventilation										
Electricians and Helpers	Skip Pit Cleaners										
Steam Shovel Crew											
Watching Engineers	New Construction										
Hoisting Engineers											
Wipers											
Oilers											
Comp'rs & Dynamo Engrs.	Total										
Boiler House Firemen											
Ash Wheelers											
Elevatormen	Trammers Day										
Coal Handlers	Trammers Night										
P'mp Sta. Eng's & Firem'n	Total										
Decker Engineer											
Deckers											
Lagging Unloaders	Miners Day										
Loco Craneman	Miners Night										
Fire Patrolmen	Total										
New Construction											
Total Surface											
Grand Total For 24 Hours											

Total Surface

Grand Total

Form CI-17—(Reduced).

The time cards are then arranged in numerical order for the purpose of entering same on the pay roll. The cards are added in series of thirties, constituting a pay roll sheet. When all the cards have been added in this manner, they are then posted to the pay roll sheet accumulative, and each sheet is balanced by adding the previous total as shown on the pay roll sheet to the total on the adding machine tape. The miners are carried on the pay roll at company account rate throughout the month, and at the end of each month the difference between the amount earned by contract and that carried on the roll is added to the earnings of each miner. This difference, or bonus as it might be termed, is posted from the contract sheets to bonus card (Form 117-C) on which name and number, (number in large type), is printed by the Addressograph. These bonus cards are filed with the other cards and after the due bills have been made out and checked against the pay roll, which is an additional check and serves as an audit of the pay roll, they are boxed and stored away for future reference. The total accumulative shown on pay roll sheets and distribution sheets must at all times balance.

From the working sheet (CI-48) a report is made out daily (Form 103-C) which shows the charges for the day and total for month to date against each account, as per the card of accounts. This report is forwarded to the General Office and at all times is in balance with the pay roll.

In addition to the complete roll which is forwarded to the General Office at the end of the month, we are able to furnish the mine management each day, from data assembled by methods herein described, the total cost of each day's operation in each division of the plant, giving as complete detail as necessary, as well as the cost for month to date. In this manner if any particular account shows an excessive cost, steps can be taken immediately to ascertain the reason therefor and remedied if possible. This daily cost is shown on Form CI-103. It will be noted that this cost is complete, including materials and other information, as we carry our supply dis-

NEWPORT MINING COMPANY

NEWPORT MINE

Daily Report of Labor for ______________________ and to date

	D Shaft	K Shaft	Total this Date	Total to Date D	Total to Date K	Grand Total to Date
1 Mine General Expense						
20 Steam Expense						
30 Water Expense						
40 Electric Light and Power						
50 Compressed Air Expense						
60 Laboratory Expense						
70 Stable Expense						
80 Shop Expense						
140 Surface Expense						
190 Dry Expense						
210 Handling Supplies						
Total Indirect Charges						
90 Hoisting Ore Expense						
100 Bradford Breaker						
110 Rock Pile Expense						
120 Stocking Ore Expense						
130 Loading Ore Expense						
150 Underground Expense						
160 Operating Main Levels						
170 Mining Sub Levels						
200 Pumping						
300 Opening Main Levels						
320 Sinking Shaft						
Total Direct Charges						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
S. R. No.						
Total Special Repair						
Total Operation Charges						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
S. O. No.						
Total Shop Order						
Bush						
Stores						
In Account with						
GRAND TOTAL						

Form 103-C—(Reduced)

NEWPORT MINING COMPANY

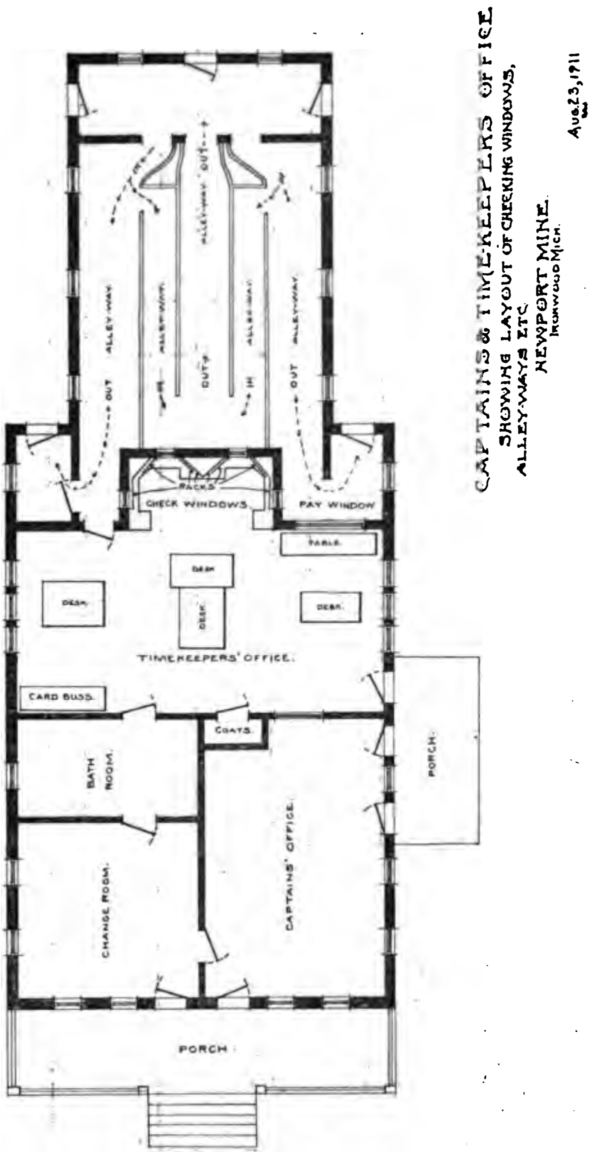
NEWPORT MINE

Daily Cost Statement for ______________________ and to date

	Labor	Cost per ton	Mater- ial	Cost per ton	Total for day	Cost per ton	Total to Date	Cost per ton
Mine General Expense								
Steam Expense								
Water Expense								
Electric Light & Power Expense								
Compressed Air Expense								
Laboratory Expense								
Stable “								
Shop “								
Surface “								
Dry “								
Handling Supplies								
Total Indirect								
Hoisting Expense								
Rock Pile “								
Stocking Ore “								
Loading Ore “								
Underground “								
Pumping “								
Mining Sub Levels								
Operating Main Levels								
Opening “ “								
Sinking Shaft								
Sinking Winze								
Locomotive Crane Expense								
Hauling Timber								
Load & Unload Cages								
Total Direct								
Spec. Rep. No.								
“ “								
“ “								
“ “								
Total Special Repairs								
GRAND TOTAL								

MEMORANDUM		
Tons Produced		
Electric Power Output		
“ “ “D” Line		
“ “ “K” Line		
Total Weight of Water Evaporated at Deg. F.		
“ “ of Coal Consumed		
Lbs. of Water Evaporated per lb. of Coal		
Average Feed Water Temperature		
Average Steam Pressure		
Boiler Horsepower in Service		
Total Horsepower Developed per cent. of Rating		
Total Horsepower Developed per hour		
Equivalent weight of Water evaporated from and at 212 Deg. F		
Cost per ton Explosive		
Lbs. of powder per ton produced		
Tons of ore per lb. of powder		
Nos. of sleighs Timber from Timber Operation		
“ “ Lagging “ “		
No. of Candles per man		

Form CI 103—(Reduced)


CAPTAINS & TIMEKEEPERS OFFICE
SHOWING LAYOUT OF CHECKING WINDOWS, ALLEY-WAYS ETC.
NEWPORT MINE
IRONWOOD MICH.
AUG. 23, 1911
CHECK WINDOWS
PAY WINDOW
TABLE
DESK
TIMEKEEPERS' OFFICE
CARD BUSS
COATS
BATH ROOM
CHANGE ROOM
CAPTAINS' OFFICE
PORCH

bursements and various other plant data on the same cumulative plan as labor. From the working labor distribution sheet, Form CI-48, as mentioned above, we are able to make up complete data showing number of men and just where employed each day on a general force report, (CI-17), by which the management is being accurately informed as to exact location of every man employed, and any changes in the organization from day to day is noted from Form C-171 made from CI-48.

We pay our employes once per month using bank checks drawn on pay roll account as a medium of settlement, and, as the names on these checks as well as on our due bills or receipts, time cards, and pay roll, are all printed by the Addressograph, it removes all possibility of the oft-times ludicrous and sometimes serious evolution of employes' names which is always cropping out when the names are transcribed from mouth to mouth, by long hand or even typewriter.

At the close of each pay period, a remainder roll is compiled (Form 84-C) which includes all uncalled for pay checks. A copy of this remainder roll is sent to the Chief Timekeeper for his reference.

In the event that an employe does not receive his check on the regular pay day, he must go to the Timekeeper's Office where he secures, upon request, Claim for Remainder Checks filled out (Form 81-C) and upon presentation of this claim together with his brass check to the Paymaster, he receives his check.

An employe leaving the service of the Company during the month receives from the foreman a settlement slip (Form CI-76), and presents same to the timekeeper's office. This slip is then filled out from the employe's time cards which are filed in the Card bus and checked with the pay roll. It is then returned to the employe who presents same to the Paymaster's Office, which is located in the main office building, where, in turn, a bank check is drawn on the Pay Roll Account and given to the employe on presentation of his brass

NEWPORT MINING COMPANY

NEWPORT MINE

DETAIL OF SUMMARY OF MEN EMPLOYED Ironwood, Mich., ____________ 191 ___

PRODUCING OCCUPATIONS	Standard	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total	Amount	Rate
Gen. Mgr. Supt. and Mech. Engr																					
Acct. Clerks and Timekeepers																					
Telephone Operators																					
Janitor																					
Safety Insptr. and Intrprtr.																					
Watchmen																					
Engineers and Draftsmen																					
TOTAL MINE GEN. EXPENSE																					
Superintendence																					
Unloading Fuel																					
Coal Handlers																					
Elevator Men																					
Firemen																					
Ash Wheelers																					
Boiler Washers and Helpers																					
All Other Producing Labor																					
TOTAL STEAM EXPENSE "A"																					
Superintendence																					
Unloading Fuel																					
Coal Handlers																					
Firemen																					
Ash Wheelers																					
Boiler Washers and Helpers																					
All Other Producing Labor																					
TOTAL STEAM EXPENSE "B"																					
(Continued Per Card of Accounts)																					

These columns continued up to 31

Form CI-171—(Reduced)

NEWPORT MINING COMPANY

Uncalled for Pay Checks for Month of————————————19

NAME	Pay Roll No.	Check No.	Amount		Paid

Form 84C—(Reduced)

NEWPORT MINING COMPANY

Claim for Remainder Checks

Date ....

Name..

Payroll Number...

Month...

Identified by ....

Signed ....

Form 81 C—(Reduced) **Chief Timekeeper**

THE NEWPORT MINING COMPANY

Ironwood, Mich.----------------,19----

PAYMASTER:

Please settle with...............................No............

In full to date account of........... ....

....

Foreman or Captain

Due for month of ....19....

..................Day at............ $.....................

....Day at............ $.....................

Total Earned $.... ....

Deductions $.....................

Balance Due $.....................

Examined by...................... ....

Form CI-76—(Reduced) **Chief Timekeeper**

check. This brass check is retained by the Paymaster and returned to the timekeeper's office for future use.

It has not been my intention to enter largely into the discussion and method of time distribution and costs, but as both are interwoven so closely with "Timekeeping," it has been almost impossible to differentiate in this paper, and I might add that we are making a distribution of both labor and supplies on a card of accounts which is so simply "keyed" that it is possible for the accounting department, with hardly any extra cost to the department or mine, to furnish a comparative cost of mining ore per ton for each sub-level, as well as complete parallel detail of each main level operation, the cost of development or both per foot and per ton of ore recovered and developed, etc.

Departmental exhibits are also furnished wherein cost of each department is shown on its own particular unit, such as Boiler House expense per Boiler horse power developed—Light and Power in kilowatt hours—Stable expense in number of Horse days worked, etc., and it is believed that the care exercised in the first operation of gathering the data in connection with each man's time is more than repaid in the results achieved by an intelligent and complete exhibit of monthly costs furnished to the management almost immediately after the completion of a month's business.

SQUARE SET MINING AT THE VULCAN MINES.

BY FLOYD L. BURR, VULCAN, MICH.

Since the invention of the square set system of timbering by Phillip Deidesheimer in 1860, at the Ophir mine of the Comstock Lode in Nevada, it has been used under widely varying conditions in many districts and may be considered to possess in a very marked degree the qualities of safety, thoroughness and general conservatism; while it is always open to criticism on the score of expense. Being used under such varying conditions and by men with widely varying ideas, it is not surprisng to find very considerable differences in the dimensions of the timber, the detail of the joints and the general application of the system.

This square set timbering was developed to take the place of simple props when the Ophir mine vein suddenly widened out with depth from 4 feet to about 70 feet. It was of course, entirely impracticable to span such a width between the hanging and foot walls with a one-piece prop or stull timber and in order to produce what would be in effect a prop made up of several pieces, the square set scheme was devised. The idea was that the compressive stress due to the weight of the hanging wall would be resisted by a series of "caps" butting against each other and held in alignment by other members acting at the joints. This conception of the function of the caps makes them the principal members, the others being more of the nature of auxiliaries. Probably this condition is most nearly true in case of steep dips. However, in the use of the system in general, there are places where the "legs" or the "dividers" may have to carry the heaviest load and indeed they must always carry certain considerable components of the main loads. It must also be borne in mind that the timber is used incidentally as staging from which to carry on the work of mining and to support temporarily considerable amounts of broken ore. These incidental functions of the timbers may indeed have a strong bearing on their manner of use and in the selection of sizes.

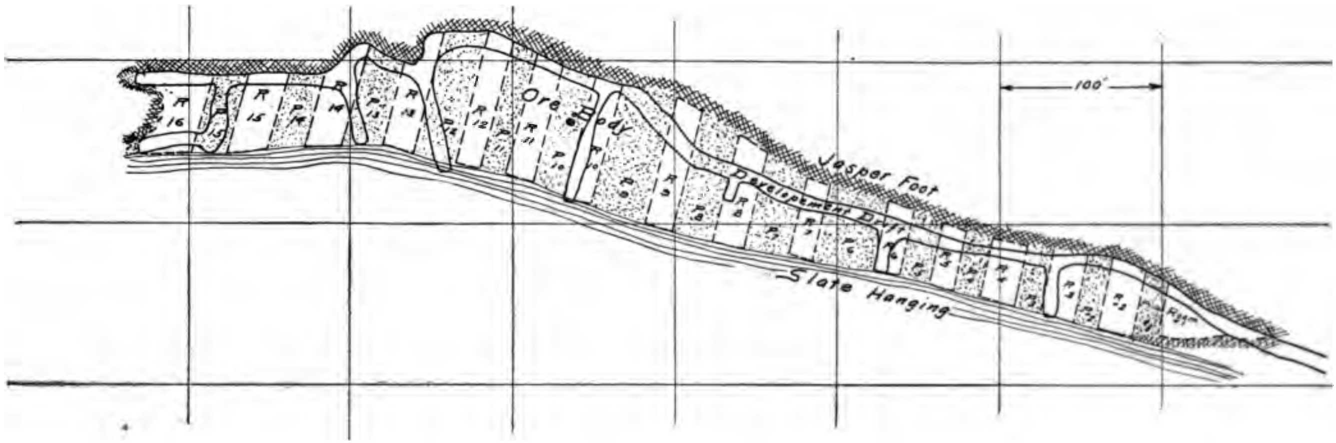
There are many systems of details for framing the ends of the pieces to form the joints, depending on the conditions of pressure, cost, facilities for framing, etc., as these conditions appear to the man who directs the mining operations; but it is my belief that timbering is carried out too generally by a blind following of the local time-honored method with little consideration of the actual requirements. To design a joint scientifically, one must first decide as to the magnitude and direction of the pressure and stress to be resisted and then dispose the timber in such a way as to best serve the purpose, it being of paramount importance to remember that timber is about five times as strong to resist compression along the grain as it is across the grain.

This square set system of timbering has made possible and given rise to a number of square set systems of mining. That in use by the Penn Iron Mining company at its Vulcan mines might be called the "square set room and pillar" system of mining. There are several other mining methods in use at these mines, the most notable of them being the "top slicing" system, which is sometimes used independently, but more often as an auxiliary to the square set work to mine out the ore pillars left between the square setted rooms. In the mining of soft or medium ores, the square set room and pillar method is applicable where the ore body is too wide for stull timbers; where it is so irregular in shape that in following out the limits of the ore the width is liable to vary greatly and unexpectedly; where the condition of the rock back is such that it will not cave down successfully for the top slicing method; where caving methods in general cannot be used for fear of destroying valuable or essential surface works; where previous operations have rendered underground conditions unfit for caving methods; where it is necessary to begin mining on several levels at once instead of progressing only from the top downward; where the output must be forced in quantity or in date; where it is considered essential to recover with certainty all the ore; and in general where conservatism is the ruling factor.

Due to the existence of some of the above conditions at Vulcan, the system has been quite generally used there. Levels are usually established at 100 foot intervals and when the ore body is encountered the drift is continued throughout the length of the ore, there being no regular practice as to following the foot or hanging walls or drifting in the middle. Some crosscutting is done at irregular intervals, thus defining the general limits of the ore body. Frequently raises are driven upward to connect with the level above for ventilation and for lowering timber.

In beginning the mining operation a line for the timbering is chosen, sometimes paralleling the timberwork on the level above and sometimes being a line parallel to the longitudinal axis of the ore body as nearly as may be approximated from the development done. When there are pillars of ore still unmined on the level above, it is of course considered essential to keep that in mind in the laying out of rooms and pillars, which comes next in sequence. At right angles to this longitudinal line which has been chosen for the timbering, rooms are laid out. These rooms are made from two to four sets, or from 14 feet 10 inches to 29 feet 8 inches wide and their length is of course the width of the ore body. The intervening pillars vary in width from two sets to five sets.

Figure 1 shows the plan of a certain level in one of our mines being worked by the square set system. This ore body is larger and more regular than many of them, but the smaller and irregular ones are worked the same way. In this figure an irregular development drift has marked out the limits of the ore in a general way and then rooms have been laid out,



Square Set Mining at Vulcan. Mich

Plan Showing

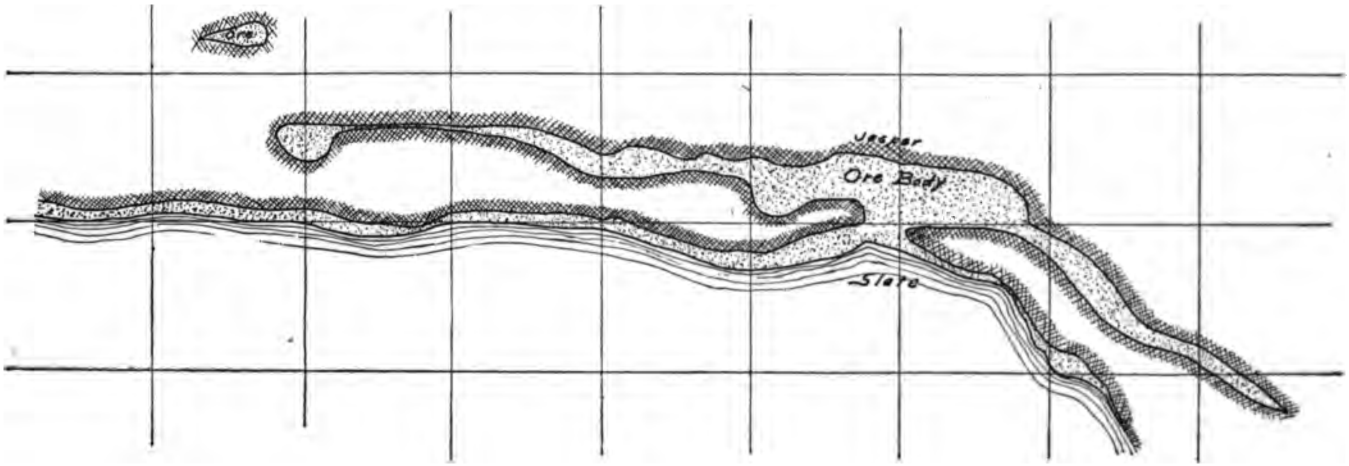
Developement Drift and Outline of Rooms and Pillars

Fig. 1

leaving pillars between them. The heavy dotted lines are the side lines of the rooms. The area occupied by pillars is shaded. Figure 2 shows the irregularity in size and shape commonly met with in the Vulcan ore bodies.

As the rooms are gradually cut out on the level, square sets of timber are placed in position and usually a set is placed as soon as there is space for it, thus avoiding large areas of unsupported back. The sets are blocked in place and 7-foot lagging are laid on top. Usually 9-foot legs are used for the first floor, while all other floors have 7-foot legs. These lower legs are usually stood directly on the ore beneath, it not being found necessary to use sills to distribute pressure or to tie the legs together. Years ago sills were used regularly. The only reason for using sills would be to facilitate the "catching up" of the debris when the room has been filled with waste rock and the workings below have progressed up to the level. Instead of using sills, the present practice is to anticipate the beginning of the filling operation by laying down on the floor of ore at the level a sheeting of 10-foot round lagging, it being comparatively easy to "catch up" this lagging when working up to it in the subsequent operations from below, and to thus avoid the caving down of loose filling material. The sides of the rooms next to the pillars are lagged up outside the legs of timber to prevent the ore from the pillar caving into the room.

After a given room has been cut out and timbered the one set in height over the whole area from hanging to foot, thus completing the "first floor," the lagging are removed over one set and an opening is cut upward large enough to accommodate a set of timber, thus beginning the "second floor." This floor and the succeeding floors of ore are in due time mined out one set at a time and the timbering left in its place until the level above is reached, or to a point some 15 feet under the level in case it is necessary to leave a floor to accommodate haulage ways or other conditions on the level above. In the most usual case when a 15-foot floor pillar is left, a raise



Plan Showing
The irregular form and size
of the Orebodies often met with at Vulcan
Fig. 2

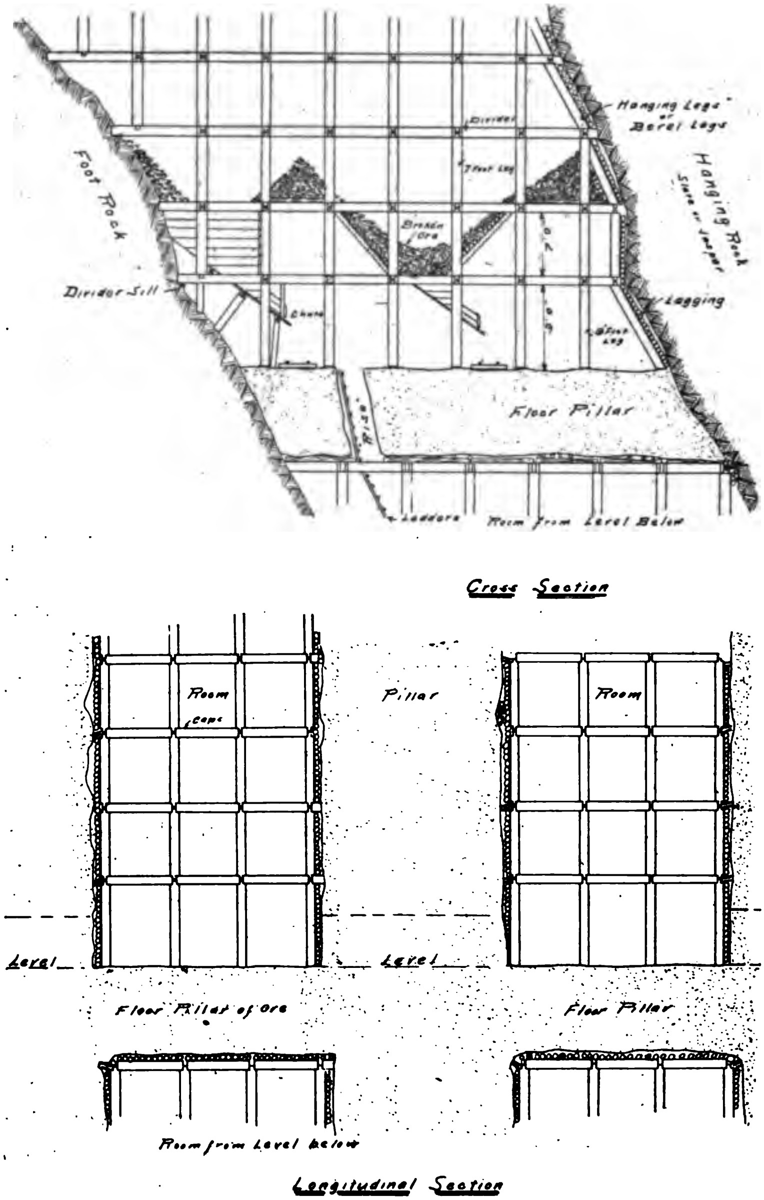
is cut through it connecting to the level above. See Figure 3.

In blasting down the ore it is allowed to accumulate to some extent on the various lagging floors and occasionally the "stope is cleaned up" by shifting the lagging like the dump-boards of gravel wagons, allowing the ore to fall down into the chutes which have been provided at the level. The various rooms in the series will generally be found in different stages, some being worked nearly up to the limit, while others are barely begun.

In the usual course of action, the rooms are filled up with waste rock produced elsewhere in the mines by the driving of exploratory drifts and other openings or sent down from surface rockpiles in cars or chutes; or in case these sources do not yield the necessary material, rock is mined for the purpose from suitable places in the hanging or foot walls. This rock is trammed in cars and dumped down from the level above until the room is full. Of course the timbers are left in place and no attempt is ever made to recover them. Before starting to fill a room, a sheeting of split lagging is placed at the side of the room bearing against the legs toward the pillar to prevent the subsequent rock filling from running out when the pillar is being worked later on.

I understand that some years ago at the West Vulcan mine the filling was "puddled in" with water and the result was a material like a water-bound macadam, concrete-like in its ability to stand up as a rigid mass. This, I presume, would hardly have required the support of lagging.

Whatever passage-ways it is desired to maintain are cored out in the rock filling. These may include a ladderway between levels, tramways on the lower level and suitable mills adjacent to the pillars. These mills are to be used for access to the pillar and for chutes down which the ore is sent when mining these pillars by the top-slicing method. When all the rooms have been worked out and filled, the pillars are usually attacked by the well known "top slicing" method. By this method the ore is mined from the top of the pillar in a "slice"



SQUARE SET MINING AT VULCAN, MICH.

Vertical Section Showing Square Set Timbering and Scheme of Mining.

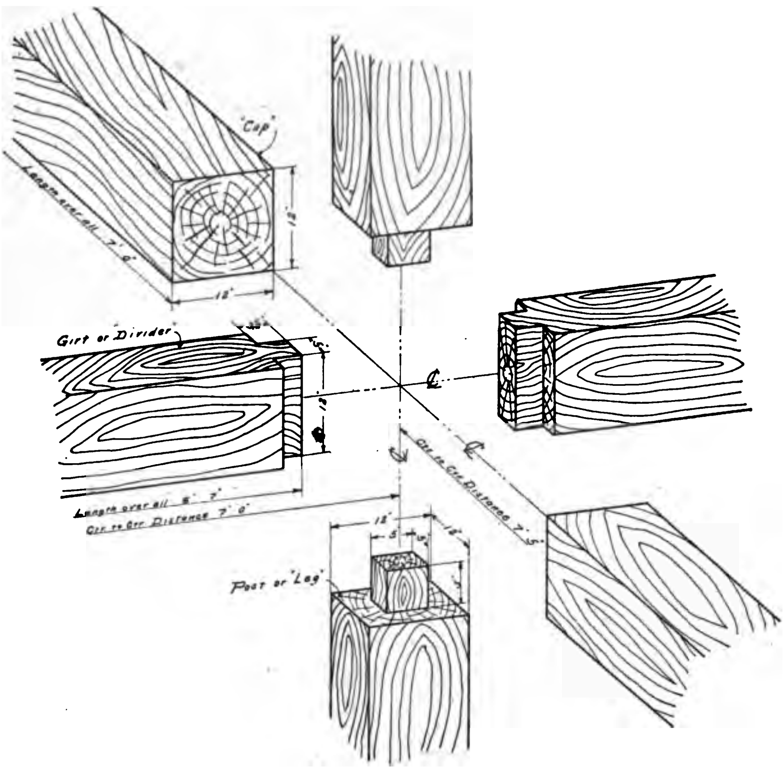
FIG. 3.

only some 10 feet in depth and the debris above caved down as each successive slice is removed. At the same time the floor pillar left over the adjacent rooms may be removed.

While the method as outlined might be called the standard method, it is frequently departed from in several ways. Thus sometimes the pillars are worked away as extensions of the rooms by what is known locally as "side slicing." This side slicing has been used considerably. To explain it: Suppose we have a pillar three sets wide between two rooms each three sets wide. After the rooms have been worked out and the square set timbering occupies the space, it may be found that no severe strain has shown its effects upon the timbering and the ore pillar shows no tendency to cave. Under these circumstances it may seem wise to risk taking off a slice one set wide from one side of the pillar. This then widens the adjacent room to four sets wide and reduces the pillar to two sets wide. This space is of course timbered with square sets precisely like those in the rooms, progressing from set to set and floor to floor. After this one slice has been successfully cut off from our pillar, we may be bold enough to risk taking off a similar slice from the other side and finally removing the remaining third producing a great room 9 sets wide; or it may be considered too risky to do this and resort be made to filling the rooms and top slicing the remaining portion of the pillar.

Sometimes the above described procedure is carried on with the variation that the rooms are filled in the usual manner with waste rock before attacking the sides of the pillars. Sometimes also after the rooms have been filled with waste rock, the pillars are "taken out on timber" as it is spoken of locally. In this scheme the pillar is treated just as if it were a room and the filled room a pillar, the whole three sets width of pillar being mined up and timbered with square sets.

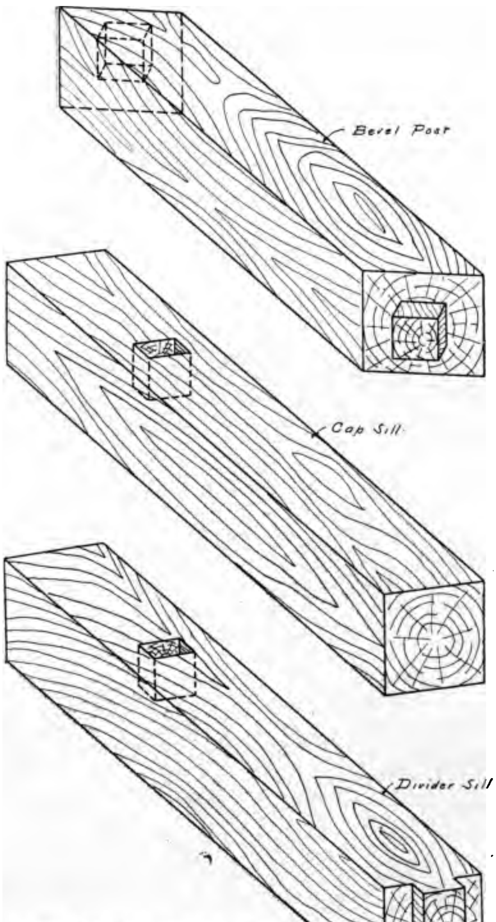
Taking up now the details of timbering, reference should be made to the sketches. In Figure 4 the joint is shown in modified isometric projection. The sketch represents 12-inch timbers, but 10-inch and 16-inch timbers are also in use, the tenons on the legs being made 4 inches and 8 inches square respectively. It will be noticed that the framing is extremely simple. A great deal of the timber is framed by machinery, but there is also some hand-framing. Both round and square timbers are used.



Square Set Mining at Vulcan Mich
Dimensions and Detail
of
Square Set Joint
Fig. 4.

Figure 5 shows a "divider sill" and a "cap sill" and a "bevelled post," and their use is indicated in Figure 3. The "divider sill" is used to allow the timbering to progress over the footwall, while the "cap sill" may come into use in a similar way at the end of the ore lense at the foot of the pitch. The "bevelled post" or "hanging post" is used in following up the hanging wall.

Contrary to the more usual practice, the caps are placed



Square Set Mining at Vulcan Mich
Detail of Special Members
Fig. 5

along the strike of the vein and the dividers at right angles. I am informed that the reason for this is that it is desired to place the overhead lagging in the direction from foot to hanging and since it must take the weight of ore blasted down upon it, it must rest on the stronger members—the caps, the caps being the stronger because they have the greater bearing area on the leg.

The legs are spaced 7 feet center to center from foot to hanging, while in the longitudinal direction they are at 7 foot 5 inch intervals.

SOME SAFETY DEVICES OF THE OLIVER IRON MINING COMPANY.

BY ALEX. M. GOW, DULUTH, MINN.

On March 23, 1908, Mr. Chas. MacVeigh, General Solicitor of the United States Steel Corporation, called a meet-

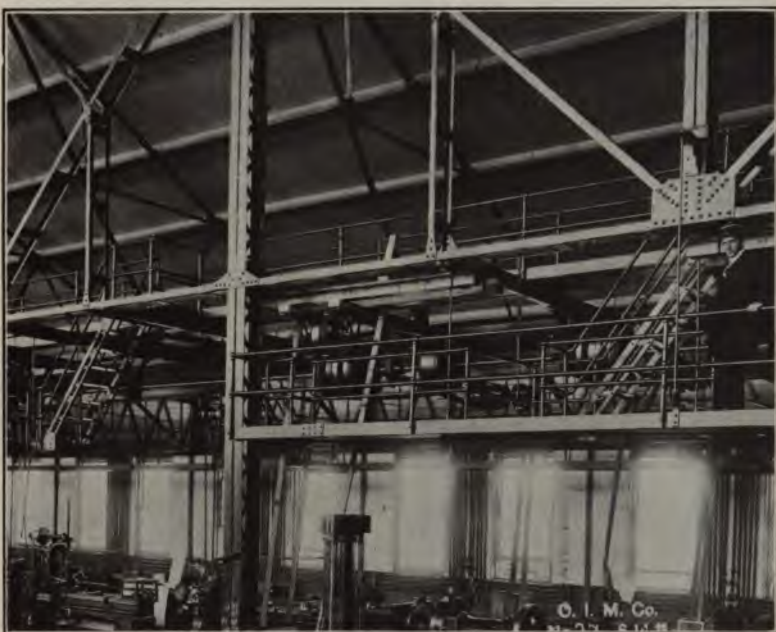
No. 1—Trout Lake Power Plant, Coleraine, Minn.

ing of the casualty managers of the subsidiary companies to consider the results of attempts that had already been made to prevent accidents, and to consider and formulate further plans for the safeguarding of employes. Judge E. H. Gary, chairman of the board of directors, gave his hearty endorsement of the purposes of the meeting and the assurance that "we will not hesitate to make the necessary appropriations in money to carry into effect every suggestion that seems to us to be practical for the improvement of the conditions at our mills so far as the question of taking care of our employes is concerned." The result of this meeting was the appointment of a committee of safety which, since that time, has been actively engaged in furthering the cause of safety to employes.

As it stands today, the safety committee of the United

No. 2—Concentrating Plant, Coleraine, Minn.

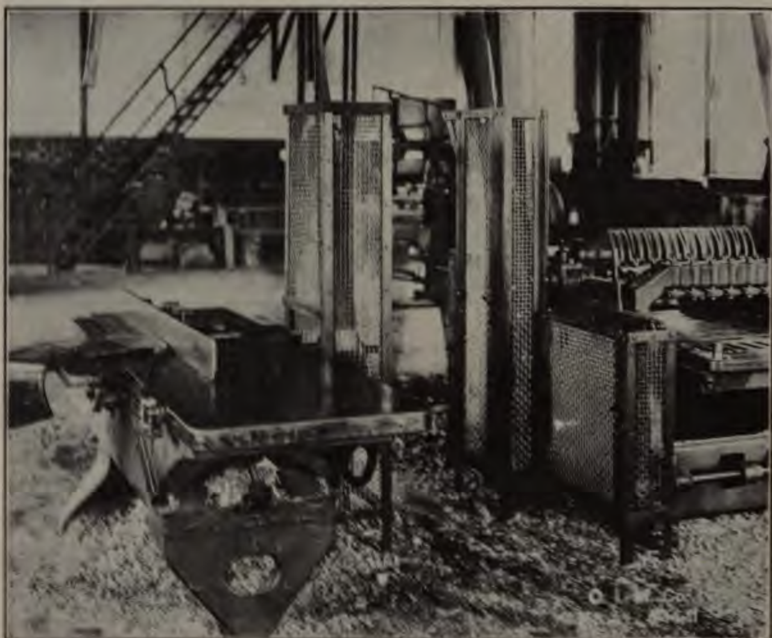
States Steel Corporation consists of seven members, with General Solicitor MacVeigh as chairman. It acts as a clearing house for all safety matters, appliances and devices. It appoints special inspection committees to visit the various plants and make reports and recommendations. It gives careful consideration to reports of serious accidents with a view of providing means to prevent their recurrence. It also assists in the voluntary accident relief plan. In addition to the general safety committee, each subsidiary company has such safety committees and safety regulations as are best adapted to secure the end that is desired. The Oliver Iron Mining Company, which is the ore-producing subsidiary of the United States Steel Corporation, has been diligently working along lines suggested by the general safety committee. A number of committees have been appointed by the management to make suggestions and draw up rules and regulations in vari-



No. 3—Canisteo Shop, Overhead Platforms, Coleraine, Minn.

ous lines of operating; for instance, one committee gives its attention to safety matters underground; another to open pit work; another to standard warning signs, etc. A large number of rules and regulations have been framed pertaining to underground work, handling of explosives, open pit operations, machine shops, boilers, etc., and reports are regularly made to the management as to how these rules and regulations are carried into effect. No reasonable expense has been spared

No. 4—Canisteo Shop, Tool Grinder, Coleraine, Minn.



No. 5—Hibbing Shop, Buzz Planer, Hibbing, Minn.

to protect the machinery in the shops, and to render mechanical operations as free from risk as possible. Owing to the limited space available in the Proceedings of the Lake Superior Mining Institute, it is not desirable to reproduce all the sixty lantern slides which were shown at the meeting. A few are selected to give a general idea of what the Oliver Iron Mining Company has done in the matter of safeguards and protection around machinery.

Illustration No. 1, reproduced from Oliver Iron Mining

No. 6—Virginia Shop, Band Saw, Virginia, Minn.

Co.'s photograph No. 1, shows the generator and engine at the Trout Lake Power Plant, Coleraine, Minnesota. Attention is called to the wire netting guard around the generator and fly-wheel, and to the steel stairway and steel platform giving access to all the valves on the steam header. One of the safety regulations require that all valves on steam lines shall be accessible by means of steel stairways and platforms, thus dispensing with the use of ladders.

Illustration No. 2, from photograph No. 6, shows an overhead platform running the entire length of the concentrating plant, Coleraine, Minnesota, so all pulleys, clutches, belts and couplings on the main line shaft can be reached

No. 7—Spruce Mine, Top of Boiler Setting, Eveleth, Minn.

without risk. The platform is fitted with handrails and toe-boards in conformity with the rules.

Illustration No. 3, from photograph No. 27, shows similar overhead platforms and stairways in the Canisteo shop giving access to all line shafts and counter shafts overhead. One of the safety regulations demands that all trestles, overhead crossings, platforms or landings must be fitted with suitable toeboards to prevent anything falling off and striking some one below.

Illustration No. 4, from photograph No. 25, shows a tool grinder in the Canisteo shop. Attention is called to the safety collars, the wheels being made tapered, and the shields around the wheels and the guard over the belt. To prevent sparks flying in a man's eye a piece of plate glass is provided

No. 8—Sec. 16 Boiler House, Ishpeming, Mich.

and the work is observed through this plate glass. This arrangement is very much liked by the workmen.

Illustration No. 5, from photograph No. 34, shows a buzz planer and a surfacer in the Hibbing shops, Hibbing, Minnesota. The safety rules demand that all belts shall be guarded up to five feet from the floor. The buzz planer or jointer is fitted with a safety cylinder head and in addition, a sliding guard is provided to protect the operator's left hand. A permanent steel stairway giving access to the overhead platforms, is shown in the rear.

Illustration No. 6, from photograph No 44, shows the guard over a band saw at Virginia headquarters shops. All band saws are similarly guarded.

Illustration No. 7, from photograph No. 40, shows the

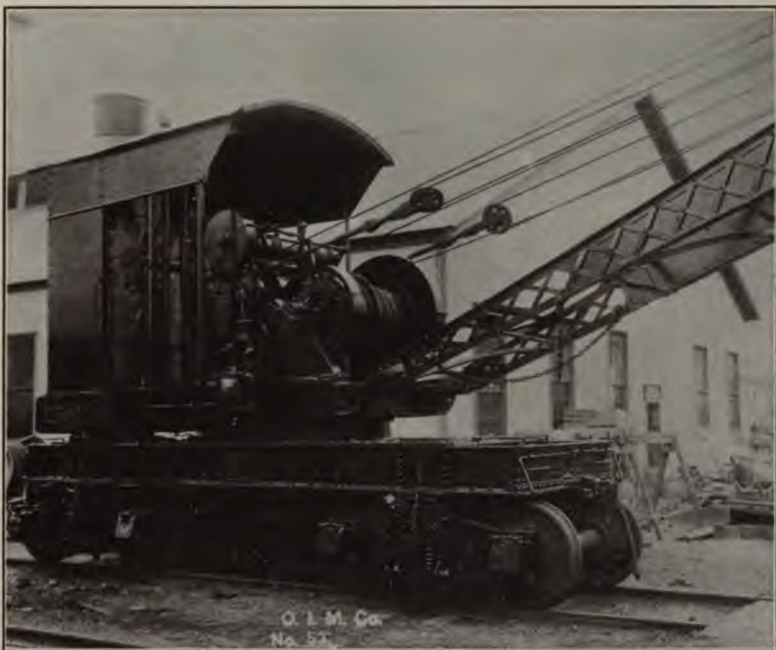
No. 9—Queen Mine Shops, Negaunee, Mich.

top of a boiler setting at No. 4 Spruce mine. The top of the setting is finished level with brick and a coating of cement. All around the setting is a handrail with toeboard and, to get access to the valves on the header, steel stairway and platform are provided.

Access to the top of a boiler setting must be by means of a steel stairway if there is room in the boiler house to get it in; if not, a permanent steel ladder must be provided. Illustration No. 8, from photograph No. 80, shows such a stairway at Section 16 boiler house, Lake Superior Mines, Ishpeming, Michigan.

All gears must be guarded. There is no exception to this rule. Illustration No. 9, from photograph No. 86, shows two lathes at Queen mine shops, Negaunee, Mich., with the change gears covered by sheet metal casings which can be opened.

A locomotive crane at Virginia headquarters is shown in Illustration No. 10, from photograph No. 52. In addition to

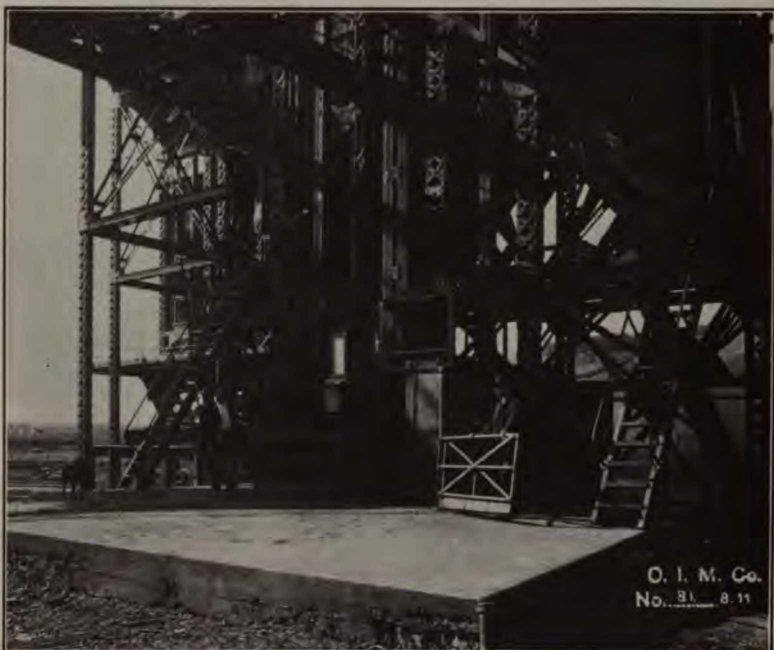


No. 10—Virginia Headquarters, Locomotive Crane, Virginia, Minn.

all gears above the car being protected, the propelling mechanism underneath is entirely covered by heavy sheet iron guards.

A steam shovel in the Canisteo Pit is shown in illustration No. 11 from photograph No. 17. Attention is called to the guards over the hoisting engine, the propelling gear and shipper shaft gear and pinion. A steel ladder with hand-rail which is permanently fixed to the boom, is provided, so that a man

No. 11—Canisteo Pit, Steam Shovel, Coleraine, Minn.



No. 12—Section 16, Steel Head Frame, Ishpeming, Mich.

can go to the point of the boom and oil the sheaves with perfect safety.

Illustration No. 12, from photograph No. 81, shows the headframe at Section 16, Lake Superior Mines, Ishpeming, Mich. The safety gates at the collar of the shaft are built of pipe with toe-boards, and are so hung that they close automatically. The cage is enclosed so that it is impossible for a man to get his arm through and be caught on a shaft set.

No. 13—Prince of Wales Mine, Steam Line and Idler Bridge, Negaunee, Mich.

The signal box is so located that signals can be given from the cage. At the collar of the shaft is built a large slab of concrete. This is for the sake of convenience in unloading material to be sent down, and also is in the interest of neatness and order. All steel shaft houses are equipped with stairways.

Where ladders are required, rests must be provided at least every 25 feet. Where it is necessary to frequently do overhead work, platforms equipped with hand-rails and toe-boards must be installed. Illustration No. 13, from photograph No. 90, shows the steam line and idler bridge, with platforms, from the engine house to the shaft at Prince of Wales mine, Negaunee, Michigan.

These illustrations are selected as being typical of the work done by the Oliver Iron Mining company along the lines of safety appliances, and similar illustrations could be taken at every operating mine and shop.

Naturally, the expense involved in this safety equipment is very considerable, but as was explained by Judge Gary, cost is a subordinate matter; safety must be given the first consideration.

DIVERSION OF THE STURGEON RIVER AT THE LORETTO MINE.

BY CHARLES H. BAXTER, LORETTO, MICH.

The Sturgeon river formerly passed over the Loretto mine, Pine creek entering the river just south of the ore body. The ore was mined out in square set rooms, pillars being left to support the surface. By this method 40 per cent of the ore was removed. 60 per cent being left in pillars.

In 1907, the Loretto Iron Company decided to divert the courses of the Sturgeon river and Pine creek to the west of the mine in order that the whole of the ore body could be mined. The work was commenced in December, 1907, and completed in July, 1908. The lower part of the cut, between Pine creek and the outlet, was first excavated, so that material from the upper portion could be wasted in the Pine creek valley, forming an earth dam which diverted Pine creek into the new channel. When the whole canal was completed, two more earth dams were built, one to divert the Sturgeon river into the new channel and one across the old river bed above the outlet of the canal, to prevent water from backing up to the mine.

The excavation was made with 70 ton steam shovels and waste material handled by small locomotives with trains of four yard dump cars.

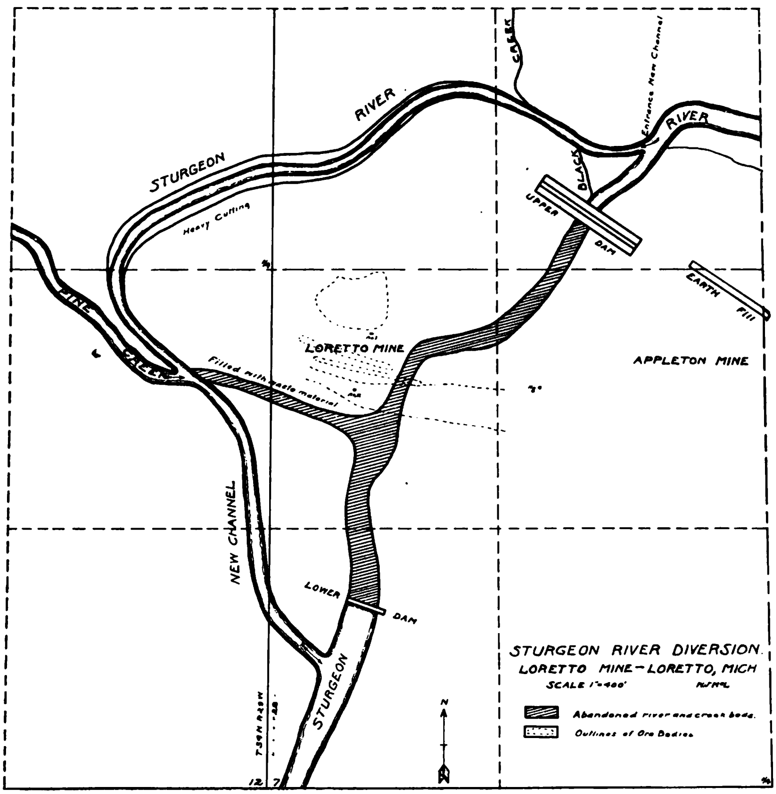
DIMENSIONS AND DETAILS.

Length	5440 feet.
Bottom width	45 feet.
Greatest depth	50 feet.
Average depth	20 feet.

Side Slopes—Earth	....	1 to 1
Rock	....	¼ to 1
Excavation—Earth	....	220,000 cu. yds.
Rock	....	40,000 cu. yds.
Grade	....	0.1%

Loretto Mine—Showing new channel made in changing course of Sturgeon River.

Upper Dam—Height	....	24 feet.
Length	....	585 feet.
Bottom width	....	100 feet.
Top width	....	24 feet.
Lower Dam—Height	....	12 feet.
Length	....	200 feet.
Top width	....	16 feet.


STURGEON RIVER
RIVER
CREEK
Entrance New Channel
BLACK
UPPER DAM
EARTH Fill
Heavy Cutting
LORETTO MINE
APPLETON MINE
Filled with waste material
NEW CHANNEL
LOWER DAM
STURGEON
N
STURGEON RIVER DIVERSION.
LORETTO MINE – LORETTO, MICH
SCALE 1" = 400'
Abandoned river and creek beds.
Outlines of Ore Bodies

RAISING SHAFT ON TIMBER IN HARD ROCK AT THE ARMENIA MINE.

BY S. J. GOODNEY, CRYSTAL FALLS, MICH.

When the shaft was raised from the 7th level at the Armenia mine, of Corrigan, McKinney & Co., the following method was used.

A winze was sunk a short distance from the main shaft on the 6th level where the best ore and least amount of water would be expected, and carried down 125 feet. Drifts were driven from the bottom of the winze both ways at the same time; one drift to open up the new level so that when the shaft was completed the new level would be developed for

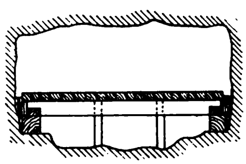


Fig 1

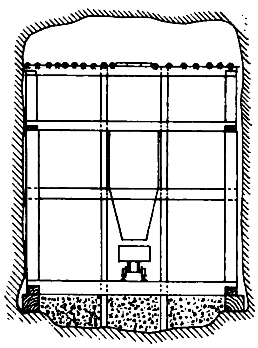
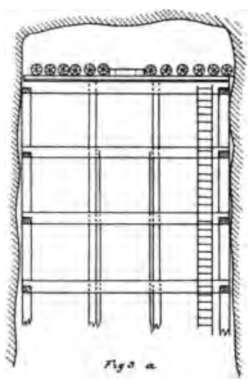
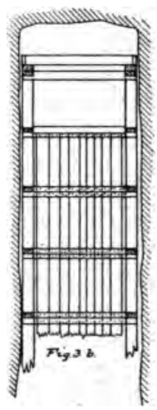


Fig 2

some distance, the other drift going to a point directly under the shaft. At this point a room was opened up the full size of the shaft, and a sink cut taken up about six feet deep. The hitches were then cut and the shaft bearers put in, also the level-set of shaft timber. This was lined up and squared with the transit, and the set blocked up solid and covered with 8 foot lagging or flat timber (Fig. 1). The back was then blasted out to make room for the station sets of the shaft. After these were in place, room was made and four sets of round timber put in the level station.

The shaft having three compartments, a rock chute was built in the center compartment by spiking plank on the inside of the divides, the plank being extended up to the second set from the top. By having one set open it insures perfect ventilation (Fig. 2). The north compartment was used as an air-way and the south compartment for the air pipe, ladder road, and bucket way to hoist drills, tools, timber, etc. A small puffer and ⅝" wire rope was used. The top set was covered with a piece of maple timber, 6"x8", laid on top of the wall plates (Fig. 3a and 3b) to protect them in blasting. The





shaft was lagged over on top of the flat timber with 10" round maple timber, hewn off a little on each end to prevent rolling. A two foot space in the center was left open for the broken rock to pass through into the chute, and for the miners to pass up to their working places. Two pieces of flat timber were put in between the round timber, one at each end, and spiked to prevent the lagging getting out of place when blasting. With the ladder road covered in this manner the danger to the men in going up the shaft after a blast is reduced to the minimum. By tramming enough rock from the chute so that it will hold all the rock from one blast, there is no danger of breaking the air pipes or ladders, and with the chute nearly full all the time it makes the ventilation almost perfect, as the farther the shaft was advanced the better the ventilation.

At first there were four miners on each shift of 10 hours each, with four hammer drills. The rock being a hard jasper and very blocky the progress was very unsatisfactory. The hammer drills were taken out and four No. 3 Rand piston drills put in mounted on ordinary 8 foot shaft bars and clamps. Two more miners were put on each shift, making three men to two drills at each end of the shaft. The rounds consisted of 32 holes drilled six feet deep, as shown in Fig. 4. All

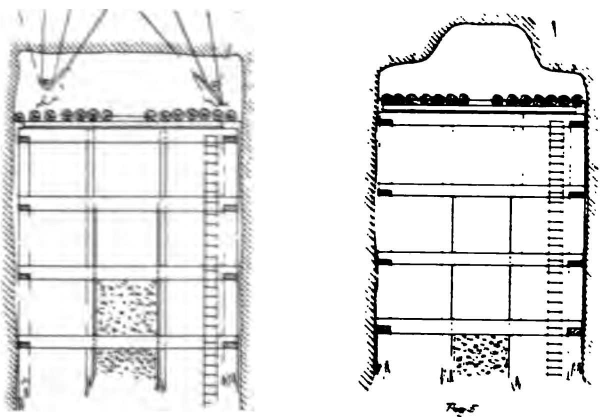


Fig 4 Fig 5

holes were fired with fuse, the electric blast was considered too heavy on the timber, the 16 cut holes being fired first. After trimming the back, a set of shaft timber was put in (Fig. 5) and lined up with the station set, (all sets being lined from station set) and blocked securely. Flat timber was put on this new set with round maple lagging and secured the same as the last set. The tools were all passed up, and the chute and ladder road extended. The remaining 16 holes, 8 on each end, were then fired. The cut being already blasted out these holes are not as heavy and do not affect the timber to any great extent. As much rock as possible from this blast was kept on the lagging making the best possible protection to the new set of shaft timber from the cut holes of the next round (Fig. 6). With this system progress was much more satisfactory, considering the hard and blocky nature of the rock. Three sets of timber per week were put in, 10"x10" shaft timber and 4 foot studdle, making 4'-10" per set.

At the same time that the shaft raise was started, there was a drift driven 20 feet from the south side of the station, where a 5'x6' winze was sunk 30 feet. A drift was driven along the hanging of the shaft from the bottom of this winze. When this drift had advanced to a point opposite the center

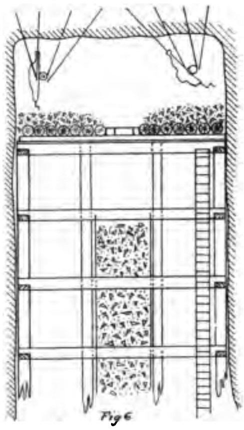


Fig 6

line of the shaft it was turned at right angles for about 10 feet, and a small raise put up. By the time this raise was holed to the level the main shaft raise had advanced to a point where a six foot test hole was drilled through into the bottom of the shaft above. On being certain that there was only six feet of rock between the back of the raise and the bottom of the shaft above (Fig. 7) the last round of holes was drilled accordingly, and let stand until all was ready to fire them. The timber in the raise was extended up as far as possible so that when the pillar was shot out it would take only one set of timber to fill the space between the new and old shaft timber. The top set in the shaft was then lagged over and blocked up solid. Then the tools were sent down, the broken rock trammed out of the chute, the chute plank taken out, also the shaft raise cleaned down and skip sump stripped, and the broken rock passed through the small raise where it was trammed with a bucket on a truck and hoisted up to the level through the winze. After completing the sump the skip runners or guides were put in, the chutes built, the car

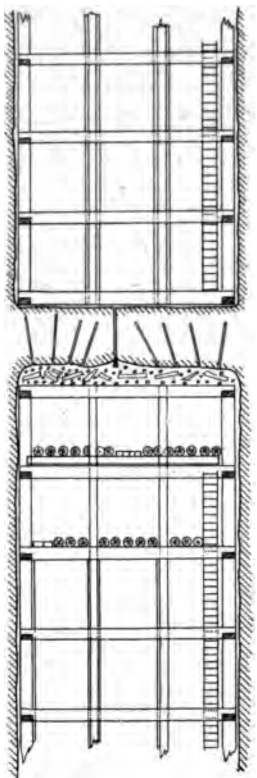


Fig 7.

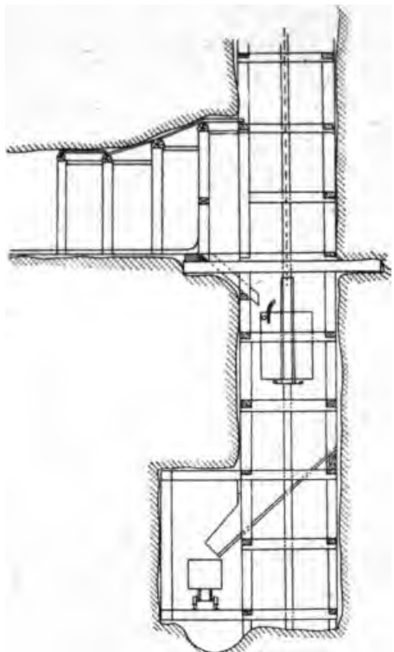


Fig 8

dumps put in, and everything completed. The pillar was shot out at 11 o'clock Saturday night and on the following Monday at noon all was ready to hoist ore, only delaying the hoisting five hours.

As previously stated the drift from the bottom of the small winze was driven along the hanging of the shaft. Fig.

8 shows the reason for this, also the arrangement for cleaning out the skip pit of all ore or rock that may fall into the shaft from the skips being over-loaded. The chutes can be emptied at any time without interrupting the hoisting of ore, as it is not necessary for any one to be in the shaft. This eliminates the overtime, as this work was usually done after 11 o'clock on Saturday night. Two men can now do the work in the same time it took eight men before. The cars are run under

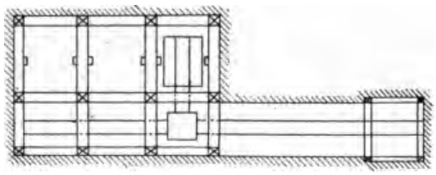


Fig 9

the chutes, and loaded the same as at any other chute, and then run to the turn sheet and put on the cage (Fig. 9) and hoisted to the next level (30 ft.) and then run back and dumped into the skip. In case the cage is in use lowering timber, or otherwise engaged, there is a truck and bucket to hoist the material through the winze dumping it in a car as usual. This, of course, takes two more men, one to land and dump the bucket and one to run the puffer.

ACCIDENTS IN THE TRANSPORTATION, STORAGE AND USE OF EXPLOSIVES.

BY CHARLES S. HURTER, DULUTH, MINN.

The study of accidents in the handling, keeping and use of explosive materials may be undertaken with two objects in view: 1st, to prevent accidents by warning against improper manipulation, careless handling and dangerous methods of using and storing explosives, and 2nd, by minimizing the destructive effects of explosives where it is not possible to guard absolutely against accidents, as, for instance, by locating magazines for explosives in such places that the damage which would result from an explosion would be reduced to a minimum.

The British government has kept detailed records of all accidents in the manufacture, storage, transportation and use of explosives since the year 1875. The British Explosive Act of 1875 was designed more to prevent accidents in the manufacture of explosives than to protect the users. The printing of the detailed reports of accidents in the annual reports of His Majesty's Inspectors of Explosives has been of inestimable benefit to the users of explosives by showing the causes of accidents and discussing the same from all points of view.

The tables in these reports, showing the number and particulars of accidents from thawing, loading, striking unexploded powder in the debris, etc., show what operations are most likely to be attended by accident as well as those operations which are most dangerous. These figures show a much greater number of casualties from loading of blast holes than from manufacture of fulminate blasting caps and the separation of

Technical Representative, E. I. Du Pont De Nemours Powder Co.

nitro-glycerine from the acids. The reason for this is easily discernible, as the first is frequently done by careless and ignorant laborers, while the others are the work of skilled and careful operators.

The English Blue Book is referred to because its issues form a compilation of every accident with explosives in the United Kingdom (England, Wales, Scotland and Ireland), since the year 1875. Whenever a man is killed or hurt in using, manufacturing, storing or transporting explosives, the particulars are at once given to the government inspector; so that they collect the details of the less serious as well as the more disastrous accidents, and it is from the former that the most valuable information can be gained. An explosion of a large quantity of powder generally obliterates any clues that might lead to tracing the cause of that explosion, while the lesser accidents, which only injure one man, often leave the man so that he is able to tell what happened.

In this country the E. I. DuPont de Nemours Powder Company has, for six years, made a systematic collection of newspaper clippings relating to accidents with explosives and it is from these that the writer has to obtain his data. This is not a very accurate source of information as compared with the English reports but it is the best obtainable in the United States up to the present time. While the larger accidents invariably get into the newspapers, sometimes in a very "highly colored" form, many of the smaller and possibly more instructive ones get no notice whatsoever. Also, the newspapers, in describing accidents, often omit what appear to be minor details, which on the other hand are of extreme importance to people interested in the safe methods of handling explosives. Even the kind of explosive causing the accident is quite frequently left out of the description of that accident.

In this paper the writer has carried parallel tables of accident statistics for the year 1910 in the United States and Great Britain. Those taken from the English reports are given because they are an accurate compilation by government officials of the details of every accident with explosives in the United Kingdom. On the other hand the records of accidents in the United States are obtained solely from newspaper clippings obtained from various clipping bureaus. As everyone knows, newspaper accounts are often not entirely accurate, details of interest to users and manufacturers of explosives are often lacking. In making a comparison of the accidents with explosives in the two countries, one must remember that the annual consumption of blasting explosives in Great Britain is about 30,000,000 pounds against about 227,000,000 pounds in the United States. In all the tables taken from the English reports the writer has reclassified the explosives, for the sake of simplicity, according to the American standards. "Black powder class" covers not only gunpowder but nitrate mixtures where paraffine, etc., has been substituted in part for charcoal "Dynamite" covers all classes of high explosives.

ACCIDENTS IN STORAGE.

The causes of accidents in storage are generally very difficult to ascertain, because the quantity exploded is as a rule so great as to leave no clue behind. It is only occasionally that a reasonable cause can be assigned to such an occurrence. Most of them are the result of the violation of rules of ordinary common sense, such as smoking, carrying naked lights, keeping detonators with explosives, brush fires where the ground around the magazines has not been properly cleared, bullets from careless marksmen, etc. To illustrate the causes of accidents in storage the following examples are given:

A terrific explosion occurred at Kimberly, South Africa, in the year 1884, of about 75,000 pounds of high explosives, and 16,000 pounds of gunpowder. The cause was laid to the probable presence of a Kaffir smoking in the shade of one of the corrugated iron magazines and igniting some gunpowder which may have leaked out through the cracks. Naturally all direct evidence of the cause of this explosion was obliterated.

On January 6, 1906, a fire started from stumps of cigarettes that some boys had been smoking, caused the explosion of fifty pounds of gunpowder stored in a barn at Sacramento, Cal., resulting in considerable damage to property.

On January 5, 1909, at Plymouth, Penn., 1,500 pounds of dynamite in a magazine exploded, doing considerable damage to property and injurying several nearby inhabitants with flying glass. This magazine was heated by steam and some dynamite came in contact with the pipes.

On January 15, 1909, some miners at Vivian, W. Va., were filling their "jacks" with powder in a small shanty, when a spark from one of their open lights caused the explosion of half a ton killing all four of them.

On April 11, 1909, at Beckley, W. Va., a man wished to kill a chicken for dinner. Being adverse to unnecessary exercise he took his rifle with him. The accounts do not state whether he hit the chicken or not, but his bullet entered a shanty containing 180 pounds of dynamite, causing him to depart for his heavenly home accompanied by a loud noise, leaving a badly wrecked house for his heirs to repair.

On December 9, 1909, a man entered a magazine at Bulls Gap, Tenn., with a lighted pipe, thereby reducing the population of that place by three and leaving four cripples. The regrettable feature is not so much the loss of the fool as the good men he took with him.

At Eaton, Ohio, on October 13, 1910, a boy fixed a target on the end of a small dynamite magazine and began practicing with his rifle. The boy escaped but the magazine disappeared and considerable damage was done to property in the immediate neighborhood.

A feature not applying to the Lake Superior district is the practice of contract miners, who use explosives in small quantities, of keeping them in their dwelling houses. This applies more to coal mining sections and is particularly true of some of the more ignorant classes of labor. Their children sometimes, when not observed, discover and get to playing with or about these explosives with the result of decreasing the population of the immediate neighborhood and keeping the medical profession busy.

In the far west, in locations distant from railroads, where supplies have to be taken long distances in teams or on pack animals, miners on finishing assessment work on claims or other work, when moving, sometimes leave what explosives they do not use in the shacks where they lived. More than one prospector has lost his life through ignorance of the presence of explosives left in this manner.

The following tables show the accidents in storage of explosives in the United States and Great Britain, during the year 1910 as taken from a collection of newspaper clippings and the report of His Majesty's Inspectors of Explosives for 1910:

***TABLE I**

Showing the total number and nature of accidents in the storage of the different kinds of explosives in the United States during the year 1910:

	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss of Life and Bodily Injury	Total Number of Accidents
	Number of Accidents	No. of Persons Killed	No. of Persons Injured		
Dynamite	13	36	61	9	22
Black Powder	3	18	6	3	6
Unspecified Explosives	3	3	20	2	5
Gunpowder	1	0	4	2	3
Blasting Caps	0	0	0	0	0
Dynamite & Black Powder	1	0	1	2	3
Dynamite & Blasting Caps	0	0	0	0	0
Fireworks	1	0	2	2	3
Ammunition	0	0	0	1	1
Nitroglycerine	3	5	0	4	7
TOTALS	25	62	94	25	50

*DuPont annual report for 1910.

***TABLE II**

Showing the total number and nature of accidents in the storage of different kinds of explosives in the United Kingdom during the year 1910:

CLASS OF EXPLOSIVE	Nature of Explosion	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss or Bodily Injury	Total No. of Accidents
		Number of Accidents	No. of Persons Killed	No. of Persons Injured		
Gunpowder	Gunpowder	6	2	8	0	6
Nitrate Mixture (Black Powder Class)	—	0	0	0	0	0
Ammunition	Shells	3	1	3	—	3
High Explosive	(Dynamite in the American Classification)	0	0	0	0	0
TOTALS	.	9	3	11	2	11

***Report of His Majesty's Inspectors of Explosives for 1910.**

The vast difference in the amounts of explosives used annually in the United States and the United Kingdom, 227,000,000 pounds vs. 30,000,000 pounds, is one of the most important reasons for the great difference shown in these two tables.

In regard to the prevention, or rather reduction, of accidents in the storage of explosives, it is of the utmost importance not to keep blasting caps or electric fuzes in the same magazine or place with explosives. These are the most sensitive and dangerous of the materials used in blasting. If anything happens to them when kept separately, the damage is, as a rule, very small. On the other hand if kept with explosives and anything happens to them, the result is often a disastrous explosion involving loss of life and great property damage. This rule should be rigidly enforced at all times. Some authorities, owing to the fact that a very small spark will ignite black powder, recommend the keeping of black powder and high explosives in separate magazines. The following accident illustrates clearly the advantage of storing detonators in separate magazines from other explosives:

On July 21, 1909, at Coplay, Pa., fire caused the destruction of a magazine containing blasting caps, injuring nobody and causing no outside damage. This illustrates very strongly the advantage of storing detonators and explosives in separate magazines. If dynamite had been stored in this magazine, the results might have been very disastrous.

The proper storage of explosives is now receiving attention from a number of state legislatures. The following shows very clearly the advance in the matter of precautions between the old and new regulations in Michigan.

OLD LAW.

Provides that no person shall manufacture, sell, keep for sale, or offer for sale, any high explosives which are not marked, branded or stamped as in this act provided, i. e, a brand or mark on each case distinctly showing the percentage of disruptive force contained in each cartridge of said case, and the name or trade mark and the address of the manufacturer, and no person by himself, agent, or servant, shall sell, keep for sale, or offer for sale any dynamite, or other high explosive not branded, or marked as provided herein. To falsely brand mark or stamp any such explosive, or sell, keep for sale, or offer for sale any high explosive bearing any false brand or mark is a misdemeanor and punishable as such. Any violation of this act is a misdemeanor and punishable as such.

The state of Michigan at its 1909 session adopted the federal act of March 4, 1909, entitled "An act to promote the safe transportation of explosive and other dangerous articles," and therefore, the federal regulations covering the transportation of explosives are by this statute made state regulations for intra-state transportation of explosives.

NEW LAW.

At the 1911 session of the Michigan legislature an act effective April 14, 1911, entitled "An act for the prevention of fire waste, and the creation of the office and the appointment of a state fire marshall, for the appointment of his assistants, to prescribe the duties, powers and authority of each, to fix the salaries for the same and to provide for salaries and necessary expenses," was passed.

This act deals generally with the powers and duties of a state fire marshal and among other powers provides as follows:

The state fire marshal shall make regulations for the keeping, storage, use, manufacture, sale, handling, transportation or other disposition of highly inflammable materials and rubbish, gun powder, dynamite, crude petroleum or any of its products, explosive or inflammable fluids for compounds, tablets, torpedoes or any explosives of a like nature, or any other explosives, including fire works and fire crackers, and may prescribe the materials and construction of receptacles and buildings to be used for any of the said purposes.

(Note): The provision last quoted was not in the bill as originally introduced; was inserted by amended bill shortly before it was enacted. As the act of 1909 above referred to expressly provides that the regulations formulated by the Interstate Commerce Commission, pursuant to section 2 of an act of congress (the federal explosive transportation act) shall be binding upon all common carriers engaged in intra-state commerce within the state of Michigan, which transport explosives by land, there would seem to be a conflict between the 1911 act, above referred to, and the 1909 act just mentioned, in this, if the fire marshal undertakes to make rules and regulations for the keeping, storing, use, manufacture, sale, handling and transportation, or other disposition of highly inflammable materials and rubbish, gunpowder, dynamite, etc., which conflict with the Interstate Commerce Commission rules, the question would arise as to which rules were effective. In my opinion the Interstate Commerce Commission rules and regulations, covering transportation of explosives, cannot in the way attempted by the legislature of Michigan become a part of the criminal law of Michigan, and therefore, section 2 of the Michigan act of 1909, attempting to make the Interstate Commerce Commission rules binding on state carriers, is inoperative. Therefore, the rules, if any, promulgated by the state fire marshal would not be held invalid, because of conflict with a prior legislative act. It is, therefore, important, in event the state fire marshal undertakes to make rules touching the manufacture, storage, sale or transportation of explosives, that we take such part as we may be permitted to take in the formation of these rules to the end that they be workable and satisfactory to the interests affected thereby.

Section 7. No person, firm or corporation, keeping dynamite for sale or use, shall store or permit to be stored within the state of Michigan, any dynamite within a building used for any other purpose.

Any building containing dynamite must be labeled "Dynamite" in letters not less than six (6) inches in height, or two inches in width, on said building. The word "Dangerous" must also be painted in plain sight of all passers by, on all sides of buildings containing dynamite.

Section 9. These regulations shall take effect and be in force from and after the 14th day of April, 1911, in accordance with Act 79 of the Public Acts of 1911, which gives the state fire marshal authority to make these regulations.

Section 10. Any person, firm or corporation who shall violate any of the provisions of these regulations, shall be deemed guilty of a misdemeanor, and upon conviction thereof shall be fined not less than ten ($10.00) dollars, and not more than one hundred ($100.00) dollars.

ACCIDENTS IN TRANSPORTATION.

The DuPont Company has records and full descriptions of quite a number of accidents to explosives in transit, where no explosions occurred, all of a sensational character. Minor ones, of which there may be hundreds, are not included. Several years ago a carload of dynamite was in a wreck at Potsdam, N Y. The car containing the explosives was badly damaged; boxes were burst open and cartridges actually fell on the tracks and were passed over by car wheels without any explosion occurring. While the fire, which destroyed the piers of the D. L. & W. R. R. at Hoboken, May 30, 1904, was in progress, a car loaded with dynamite intended for use in the tunnel was pulled out, a mass of flames. The car, blazing fiercely, was rushed back into the yard and water from a dozen lines of hose turned on it, finally extinguishing the fire. There was no explosion.

A sensational accident was reported to have occurred on

April 13, 1906, in a mine near Salt Lake City, Utah. While driving a mine train of nine cars loaded with dynamite into the tunnel of a mine, one of the cars was overturned, the dynamite exploded and the driver, who was hurled back a distance of forty feet, was stunned but not seriously hurt. None of the other cars exploded. Each car contained 200 pounds of dynamite. Blasting caps were probably being transported with the dynamite and caused it to explode. On the other hand in the same collection are found a fairly large number of accounts of accidents to explosives in transportation that resulted in serious explosions. Over half were caused by fire and the rest by collisions.

Shooting at marks which present themselves along highways and railroads is a favorite pastime of some people. Trespass signs, semaphores, notices, guide boards, tool houses, and abandoned buildings peppered with shot are common sights all over the country. Boys shooting into structures supposed to be unoccupied has always helped toward keeping down the tramp population. The records are full of accounts of explosions caused by ignorant people shooting into magazines or cars containing explosives. While it is a comparatively simple matter to construct magazines with walls that will stop a high power rifle bullet, this is hardly practicable in the case of freight cars. The cause of a disastrous explosion of three cars of dynamite at Johannesburg, South Africa, several years ago, is laid to a stray bullet. About fifty people were killed in this accident.

About the most appalling accident in the history of explosives occurred on November 3, 1893, when the Spanish steamer "Cabo Machichaco," arriving at the harbor of Santander, Spain, was found to be on fire. Her cargo consisted of wine, flour, petroleum and 1,810 cases (47 tons) of dynamite. Until thirty cases of dynamite, stated to be the entire amount on board, were taken out, the ship was not allowed to come alongside the quay, which became crowded with spectators watching the sight of a ship on fire. After burning for two hours and a half, a terrible explosion occurred, which killed 520 persons and injured about 1,000 more, besides doing an immense amount of structural damage to the town. Compared with the Santander disaster the accidents in the transportation of explosives in this country have been comparatively mild.

On June 8, 1900, train No. 61, local freight on the D. L. & W. R. R., containing a carload of dynamite placed next to the caboose, in violation of the railroad's regulations, stopped at Vestal, N. Y., and the train was left standing on the main track, while the engine went to the water tank just beyond the station. Through a misunderstanding of signals a "wild cat" engine crashed into the rear of the train, No. 61, exploding the car of dynamite. Five persons were killed and many injured. The property damage was several thousand dollars. Since that time the "Bureau for the Safe Transportation of Explosives" has been organized, which has made an ironclad rule that cars containing explosives must be carried in the middle of freight trains. The excellence of the above rule is shown by the results of the following accident. On December 18, 1909, a carload of dynamite was exploded near Dunkirk, N. Y., by a rear end collision between freight trains. The explosion did considerable damage to property but nobody was killed or injured. The car was in the middle of the train. The following is a good example of the result of carelessness. On December 10, 1909, an explosion of 35 kegs of blasting powder and a keg of smokeless powder in a freight car occurred in the Minnesota transfer yards at St. Paul, Minn., killing one and injuring two men. This was caused by a man driving a nail into a keg while bracing the powder for shipment.

One of the most disastrous accidents in the transportation of explosives in this country occurred at Harrisburg, Pa., on May 11, 1905, causing the death of about twenty-five passengers. There was a collision between a westbound express and a "buckled" car containing a low grade nitroglycerin explosive in an eastbound freight train, which fell across the track in front of the express. There was no explosion due to the collision but in the fire which immediately followed, at least four explosions occurred. There was no suspicion of a crater where the car of explosives must have been, so that it is hard to believe that a large quantity of powder was involved in any one of the explosions. Parts of a great many boxes which contained the powder were scattered all around, showing without doubt, that not all had exploded.

In the transportation by water care must be taken to prevent water coming in contact with the explosives. In the cases of blasting powder and blasting caps these are ruined and rendered comparatively harmless by contact with water. On the other hand water will dissolve the nitrate of soda in the dope of the American dynamites and replace more or less of the nitroglycerin in all but the gelatins. This exuded nitroglycerine is liable to collect in the bottom of vessels, or be absorbed by wooden planks, making an accident liable to occur at any time. In the transportation of explosives care must be taken at all times to keep blasting caps and electric fuzes apart from other explosives. Detonators are the most sensitive and dangerous of all explosives but when kept apart the result of any accident to them is usually insignificant to what it would be if they were close enough to set off other explosives. Detonators should not be transported in the same car with explosives or in the same hold or compartment in vessels. In the case of team deliveries small quantities of blasting caps can safely be carried in strong padded wooden boxes arranged so that the boxes containing the detonators cannot move. Also explosives should not be carried with matches, inflammable oils, pig iron, heavy steel castings, etc.

A fair comparison of the accidents in the transportation of explosives in the United States and the United Kingdom is impossible. The rail hauls in the United Kingdom are few and short. Explosives are carried as much as possible by water in steamers owned by the companies with the result that accidents in transit are very rare.

To show the beneficial effect of the rules laid down by the Bureau for the Safe Transportation of Explosives, the following *comparative table of accidents in transportation, during the years 1906 and 1910, is shown:

YEAR	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss or Bodily Injury	Total Number of Accidents
	Number of Accidents	Number of Persons			
		Killed	Injured		
1906	20	43	337	5	25
1910	2	1	4	5	7

*Taken from DuPont annual reports.

The 1906 list contains the Jellico, Tenn., accident which killed 10 and injured 200 people. One of the causes advanced for this explosion was that the car of dynamite was bumped by one containing pig iron. The other was that it was shot into by a careless marksman. The rules laid down by the bureau not only decrease the possibility of accident but reduce the probability of loss of life and damage to a minimum. At the present time accidents in the actual shipment of explosives by rail in the United States are almost unknown. It is interesting to note that none of the accidents to blasting explosives in transit in 1910 caused either loss of life or injury to people.

The writer feels that he cannot leave the subject of accidents in the transportation of explosives without mentioning the valuable work done by Maj. B. W. Dunn and the "Bureau for the Safe Transportation of Explosives." The rules covering the transportation of explosives laid down by this bureau are second to none in the world and have doubtless prevented many accidents and saved many lives. The excellent work done by Major Dunn and his associates deserves the commendation of everybody connected with the manufacture, transportation, use of explosives and in particular that of the general public.

ACCIDENTS IN THAWING DYNAMITE.

While accidents in thawing dynamite really belong under the heading of "Accidents in the Use of Explosives" the writer considers this subject one of sufficient importance to be treated by itself. This class of accidents is interesting in that it offers more chances for mitigating its dangers, and more promise of returns from educating the consumers, than any other. The man who designs or uses the thawing house is generally of a higher intelligence than a laborer and is more amenable to reason. A blaster may "know it all" in regard to the correct method of loading and firing his blasts, but the "boss" is generally willing to accept suggestions regarding the methods of thawing. A method often found at places where more than a case per day is used, is a box or house with a steam coil on the floor over which the dynamite is supported by slats or boards. This method offers an excellent opportunity for the nitroglycerine to exude if the temperature becomes unduly high and for it to drop on the hot iron pipe. It has been a generally accepted theory that when nitroglycerine is dropped from a height of a foot or so on a hot metallic surface it will explode, and it has been known positively to do so when the heated metal is a stove lid. A thawing house in Connecticut, which was constructed so that exuded nitroglycerine could drop on the steam coils, exploded not long ago and the accident was explained on this theory. The danger is greater with high grade straight dynamites than with the gelatins or ammonia dynamites.

As to frequency of accidents from the various methods of thawing, reference will be made again to the British government reports, which cover all accidents in thawing dynamite from the year 1872 to December 31st, 1910. These are given in order of frequency:

1. Heating over or in front of a fire 41
2. Reheating water in which dynamite has been placed to thaw 11
3. Placing explosives in water, then heating it over a fire 10
4. Placing dynamite in ovens 8
5. Thawing cartridges in the hands over a lighted lamp or candle 7
6. Placing dynamite in hot ashes 7

7.	Placing cartridges on top of a stove	7
8.	Warming on a shovel over a fire	5
9.	On hot iron	4
10.	On a steam pipe	2
11.	Rubbing cartridges together to warm them by friction	1
12.	Overheating	1

The casualty list in the United Kingdom gives during this period 80 killed and 129 injured by these accidents. The records in the United States, taken from newspaper clippings during the year 1910 show 24 accidents in thawing causing bodily harm with a casualty list of 31 killed and 22 injured. Four accidents in thawing occurred that did no bodily harm making a total of 36 accidents in thawing dynamite in this country during the year 1909.

A table showing the accidents in thawing in the United States in order of frequency for the years 1909 and 1910 is as follows:

		1909.	1910.
1.	Over or before an open fire	18	10
2.	Unknown causes	6	9
3.	Over or near a hot stove	5	3
4.	Over a hot boiler	2	
5.	Over a naked light	1	
6.	In contact with hot bricks	1	
7.	In water over a fire	1	1
8.	Rubbing in hands	1	
9.	Burying in quicklime	1	
10.	Thawing inside a miner's shirt		1

Every method of thawing dynamite given in these tables is specifically condemned by all manufacturers of explosives and warned against by nearly all existing literature on the subject. Two of these accidents were unique. On March 25, 1909, a man placed some hot bricks in a bag with some dynamite to thaw it. In this case the powder caught fire before exploding enabling the man to escape. On December 11, 1909, a negro, near Richmond, Va., was thawing dynamite before a fire, the result being the ignition of the explosive. The negro's sense of economy being better developed than that of the common variety, caused him to try and beat the fire out with a club. It took several men the best part of a day to collect enough of him from the local scenery so that his relatives and friends could have a bona fide funeral.

A great many blasters, in this country, toast dynamite over a collection of candle stumps; blow live steam into a box containing dynamite, thereby unintentionally extracting a considerable quantity of nitroglycerine, which lies in a dangerous puddle on the floor, roast dynamite around bonfires, on top of and under hot boilers and soak the cartridges in buckets of hot water, which water is dumped outside where there is continuous travel, without accident, showing the amount of ill-treatment that nitroglycerine explosives will stand, sometimes.

The records show two specific instances where thawing houses, heated by a stove in the middle of the room, have exploded. These explosions took place in the middle of the night some time after the rooms had been locked. One took place in Kansas and the other in Pennsylvania. One of the favorite and dangerous methods of thawing dynamite in the United States appears to be toasting it in front of fires. The oven is also a popular receptacle for frozen powder. Past records show numerous accidents caused by thawing dynamite in hot sand. The only variation, as a rule, is the time before action is obtained and the difference in size of the casualty list.

The insertion of blasting caps and the making of primers in the same room in which dynamite is being thawed has undoubtedly been the cause of several bad accidents. That near the Murray Hill hotel, in New York city, on January 27th, 1902, was apparently from this latter cause, combined with a fire in the waste paper from the wrappers. For this reason the leading manufacturers recommend, that for outside work, the thawing houses be constructed so that it will be impossible for a man to get inside at all, except to repair radiator, etc. The door to this entrance should be locked at all other times. Overheating the thawing house by steam pipes has also caused several explosions. If it is impossible to substitute hot water (the safest method of heating) for steam, at least one should insist on the outlet of the steam pipe being left free and wide open, so that the steam is not under pressure. A valve should be placed on the pipe leading into the thawing house but never on the outlet.

The observance of a few simple precautions should prevent practically all possibility of accident in thawing explosives. Always keep the cartridges laying on their sides. Heating slowly at temperatures not to exceed 80 to 85 degrees F., the lower temperature being best, always keep the dynamite in good condition. Take all possible precautions to prevent overheating and never place the dynamite directly above the source of heat. Never thaw dynamite by direct contact with steam, by placing in hot water or before open fires And lastly, never keep blasting caps or electric fuzes in the thawing house. Since the introduction of low freezing dynamite, there has been a marked diminution of accidents from thawing in the United States. During the year 1906, two years before the introduction of the first low freezing dynamite, there were reported 64 accidents from thawing dynamite against 28 in 1910, the third year in which low freezing dynamite was on the market.

ACCIDENTS IN THE USE OF EXPLOSIVES.

The number and variety of ways that trouble can develop in this class seems to be infinite and new ones seem to be invented every day. The accidents in which people have been killed or injured by not taking proper care in the use of explosives are all carefully reported in the United Kingdom, but are rarely given in the newspapers of the United States, where the accidents are not of a serious nature. In the English report for 1910 there were 6 cases mentioned where shots blew through into another working place injuring men working there. Such accidents are entirely unnecessary if proper warnings are given and heeded. Aside from this, one of the most common operations in which accidents, in the use of both dynamite and black powder in the United Kingdom occur, is the loading and tamping of charges. It is interesting to note from the English report for 1910, that with dynamite four cases occurred and seven with black powder, where copper, brass, iron, or composition tamping rods were used. This shows that all metal tamping sticks should be avoided, only wood being a safe material.

In reference to accidents in the loading and tamping of charges, the following quotation is taken from the "Report of His Majesty's Inspectors of Explosives for the year 1910." In part this does not apply to the United States, as explosives here are packed in cartridges of standard outside dimensions all over the country:

"There were 36 accidents in ramming or stemming the charge, causing seven deaths and injury to 36 persons. In ramming charges into a borehole there must always be some danger, and it cannot be too strongly urged that this operation should be carried out with the least possible exercise of force; but there can be little doubt that in all these cases undue force was applied. The best method of preventing this class of accident is to insure that the men are not allowed to use drills which have become much worn, and also that the diameter of the cartridge is such as to give good clearance even with a slightly worn drill. It is most important that the cartridge shall not stick in the bore hole, as if it does the miner is quite certain to use sufficient force to get it to the bottom of the hole, as to fire the charge half-way down the hole would entail him the loss of half his work. We have suggested to various members of the explosive trade the advisability of standardizing the diameters of the cartridges supplied by them to the mines. In the manufacture of blasting cartridges some little difference in practice obtains; some firms considering that a 1-inch cartridge is one that has been squirted through a 1-inch die, others making an allowance for the paper wrappers. Consequently in a mine in which the men have been in the habit of using a cartridge made by one of the latter firms they would find the drills a shade too small to work with the cartridges of the former's production. Our proposal has been that the cartridges should be made exclusively of certain standard "over all" diameters (22, 33 and 44 millimeters have been suggested) and that these cartridges should be known as sizes 2, 3, 4, etc., and that intermediate sizes should not be made after a given date. This would cause a slight expense in altering drills at some mines, but we learn that the cost of this in a certain large mine was only about £7, so that this should form no insuperable obstacle. After the care which should be devoted to the drills, the other points which require at-

tention are (I) to avoid bunching the cartridges (i. e., tying two or three together or otherwise inserting several at the same time), (II) the use of wooden rammers, (III) the thorough softening of all nitroglycerine explosives before use. Even with all the above precautions, however, the use of undue force may always cause an accident. A general impression seems to exist that, at any rate in the case of gunpowder, no amount of ill-treatment with wooden, or even copper, tools can possibly lead to danger, whereas, as a matter of fact, sufficient heat to ignite gunpowder may without much difficulty be produced by the contact of two particles of flint or other hard substance without the intervention of iron or steel—the absence of which therefore merely reduces the risk."

Frozen nitroglycerine has some very contradictory properties. It is more insensitive to the shock from a fulminate cap or a rifle ball when in that condition but on the other hand it appears to be more liable to explode on breaking, crushing, tamping, etc. Every year there are numerous accidents due to users tamping frozen dynamite and there is an average of five to six cases each year where workmen have been killed or injured simply by breaking a frozen cartridge of dynamite in their hands. The fact that the dynamite does not as a rule explode with its full force is shown by the fact that more men are injured than killed by this operation. Attempts to use frozen dynamite should always be prohibited as aside from the danger of this practice, it is practically impossible to get the full explosive force from it. Out of 19 accidents in loading and tamping charges in the United Kingdom during the year 1910, 8 were due to attempts to use frozen dynamite.

Accidents from sparks, flames, etc., to be disastrous generally, though not always, require the presence of either black powder or primers Thus throwing lighted matches around, a favorite American habit, gets immediate results with black powder, but only after a lapse of some time in the case of dynamite cartridges, unless blasting caps or electric fuzes happen to be present. An occurrence which narrowly escaped being an accident happened in the New York subway tunnel under 194th street in March, 1904. The blaster after preparing his primers by inserting an electric fuze in each cartridge of a box of gelatin, proceeded to remove the wrappers from the cartridge of six more cases of gelatin. These wrappers soaked in paraffine and possibly containing a trace of nitroglycerine were heaped up over the box containing the primers. A driller from the heading came down to speak to the blaster and placed his naked bug light among the wrappers so that the flames just escaped reaching the paper by about half an inch. After burning cheerfully in that position what seemed an interminable period, the bug was casually removed by the blaster to the intense relief of at least one of the spectators.

The obvious remedy for this class of accidents is to keep sparks and flames away from all explosives. On no account should any explosive be taken into a blacksmith shop or boiler room. Smoking should be absolutely prohibited on any work while explosives are being used. The practice of removing the paper wrappers of cartridges of dynamite, while a common one in some parts of the country, should not be encouraged, or if it is impossible to prevent, the wrappers should be immediately taken away from the vicinity of the explosive. In one quarry in New Jersey it is the practice for laborers to save the paper wrappers from their dynamite cartridges for kindling their fires at home although they state that they do sometimes spoil a stove.

In the United Kingdom, the most common source of accidents in the use of explosives is from sparks, flame, etc. These all occurred with explosives of the blasting powder class. With the black powder class of explosives contact with sparks or flame brings immediate action while with high explosives, unless detonators are attached, the explosive generally burns at least long enough to enable anybody in the immediate vicinity to escape. Practically all these accidents were caused by miners carelessly wearing open lights in their hats while preparing charges for blasting. The practice of wearing naked lights in the hat, common among a very large number of miners, while filling cartridges with black powder or while making primers of high explosives, is extremely dangerous and should be absolutely prohibited if possible. There are several records where men have lost both hands and sometimes have been blinded in addition, by the falling of a spark or a drop of hot candle grease from lights worn by them into an open box of blasting caps held in their hands This has also been known to cause very disastrous explosions when this kind of an accident has occurred in the presence of dynamite.

PREMATURE EXPLOSIONS AND FAILING TO GET AWAY IN TIME.

Accidents from these causes generally are the result of gross carelessness. This class of accidents both in the United States and in the United Kingdom claims a large number of victims.

A great many of these in the United States are caused by the use of too short a length of fuse, known in some mining districts as "skin em back" shots. In some sections of the United States, it is a common practice in loading holes to use only from one foot to eighteen inches of fuse on the primer. The miner lights the fuse, pushes the primer into the hole, shoves a tamping dummy on top and runs. Sometimes the primer sticks and the man gets caught while trying to dislodge it. One or two gas or dust explosions in coal mines have been caused by this method of blasting, where the flame blew out on account of poor tamping.

The writer saw a man narrowly escape death when using this method of blasting by pushing the lighted end of the fuse down on a primer of 60 per cent nitroglycerine dynamite. The preliminary burning of the dynamite allowed the man to get back about six feet from the hole when the fire reached the blasting cap, exploding the dynamite. This method of blasting should be absolutely prohibited as the saving in dynamite that can be made when it is properly tamped will more than pay for full amount of fuse necessary to reach outside the hole.

In England a large number of premature shots (nine during 1910) as well as hang fires (two during 1910) occurred with the use of squibs. While blasting with squibs may have certain advantages, the very greatest care should always be taken in using them to avoid getting caught by either "premature" or "hang fires."

In the English report of 1910 there were records of ten accidents resulting in one death and injuries to nine persons from electric blasting with a man at the shot hole. All of these accidents occurred in coal mines. One accident in 1909 was caused by the lead wires accidently coming in contact with the terminals of a dry cell battery while the shot firer was connecting the shots at the face. Those of 1910 were due to the shot firer firing the blast before the persons at the shot hole had taken cover. Records of this class of accidents in the United States are very few. On September 14, 1909, at Nehalem, Oregon, a blast of 10,000 pounds of dynamite had been prepared. The blaster trying to move the connected blasting machine to a safe position, fell, pushing the plunger down, which caused a premature explosion killing one and injuring five persons. A safe rule to prevent this kind of accident is to have the man, who fires the shot, be the last to leave the face and for him alone to connect the leads to the blasting machine. Lead wires should never be connected with the source of the firing current until the time to fire the blast. This rule should never under any circumstances be disregarded. Occasionally miners get caught in wet places being delayed by the difficulty experienced in lighting fuses.

HANG-FIRES AND RETURNING TOO SOON.

This class results from the use of squibs, caps and fuse instead of electricity for firing the blast though not exclusively. It is entirely inexplicable why an electric exploder should ever hang fire, and that they ever do is doubted by many; nevertheiess there have been several circumstantial accounts of an entire line of holes going off several seconds after the rack bar struck the shunt spring at the bottom of a blasting machine. Several authentic cases are on record where the exploder set fire to the dynamite which after burning for some time in the bore hole eventually exploded. At one place a blast hole loaded with dynamite missed fire. The next day, it is said that two holes were drilled near it, charged with black powder and fired. After a lapse of several seconds the blaster returned to the hole, when the dynamite exploded, injuring him fatally. In this case the dynamite was probably ignited by the gunpowder and burned until heat enough was generated to explode the remainder. With ammonia dynamite an accident of this kind would hardly be possible on account of the difficulty with which the ammonia dynamites are inflamed.

Three instances were reported in Great Britain in the year 1900 where a fuse hung fire for at least 55 minutes. At a quarry near Wilmington, Del., a case occurred where a fuse hung fire for ten minutes. Since the substitution of hemp and jute to the exclusion of cotton for the body of practically all but the cheapest fuse manufactured, the records of hang fires have almost entirely disappeared. However, it is a pretty safe rule to prohibit the approach of a missed cap and fuse shot for at least one hour. In some English and American coal mines the time is increased to 24 hours.

When practicable, it is most desirable that blasts in large quarries and mines should be so timed that at least half an hour must elapse before the workmen return. This is accomplished in most mines by having the men shoot when going to lunch and off shift. This also gives the faces a chance to be properly ventilated before the men come back to work.

TAMPERING WITH MISSED SHOTS.

This is the cause of quite a large number of accidents every year. Particularly in hard rock and where miners work by contract, the men will almost invariably try to save a missed hole by extracting the charge rather than drill a new hole. This is a very dangerous practice and should be avoided at all times. A number of accidents are also caused by drilling a new hole so close to a missed shot that the drill entered the unexploded charge. Another bad practice is the blowing out of missed charges by means of compressed air. A miner doing this at Webb City, Mo., on July 24th, 1909, killed himself and severely injured his partner.

Accidents in loading and tamping, tampering with missed shots and striking unexploded powder in debris are much more frequent in the winter than the summer months. These are due largely to the tamping and use of frozen or chilled dynamite. In cold weather blasts, where nitroglycerine explosives are used, should be fired as soon as loaded to prevent the possibility of chilling or freezing on standing. With a view of giving details of these kinds of accidents, the writer inserts the following taken from the "Report of His Majesty's Inspectors of Explosives" for the year 1910:

"With a view of throwing light on the occurrence of accidents under the three headings 'Ramming, etc.,' 'Boring into unexploded charges,' and 'Striking unexploded charges in the debris,' we again give a table showing the number of accidents which occurred during each month. Only those in which an explosive containing over 10 per cent of nitroglycerine was involved are here shown. This table shows in a most marked way that the bulk of these accidents occur in the first three months of the year. They disappear almost entirely during the summer, and show a tendency to recur as the weather gets colder again. It is found that during the first three months of the year explosives of this class are more likely to be frozen than at any other time, as it takes some time for the explosive to become frozen in the magazines; indeed, it is more often that it becomes frozen during conveyance than during storage. These facts taken together render it more than probable that to the employment of frozen explosives may be atttributed the great majority of accidents. It will be seen that during the past ten years 337 accidents have occurred during the winter months—December to May—while during the remaining six months the number was only 118."

CAUSE—1910	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
Ramming or Stemming the Charge....	3	2	1	3	3	....	1	....	....	....	3	3
Boring Into Unexploded Charges......	3	....	1	....	4	3	3	1	1	1	...	2
Striking Unexploded Charges in Removing Debris	1	1	....	1	1	....	....	....	....	....	2	2
Total of Above Causes	6	3	2	4	8	3	4	1	1	1	5	7
Total Number in Past Ten Years	62	69	77	48	32	22	21	12	19	17	27	49

These figures are such as to afford some reason for thinking that the efforts which have been made to induce users of this class of explosives to make a regular habit of using a warming pan during the winter and spring months are beginning to be effectual. We have been encouraging magazine owners to adopt some method of heating their magazines and already some have been so fitted. The best method seems to be the use of hot water circulating pipes heated by a slow combustion stove at some little distance from the magazine adapted for burning coke, anthracite or coalite. It would appear to be a fact that explosives which have never been allowed to become hard by solidification of the nitroglycerine do not show so much tendency to freeze as those which have been frozen once and subsequently thawed. Even so, however, any measure of warming magazines can only be regarded as a palliative for the evil, the true remedy for which is the regular and proper use of warming pans by the users.

Every year there are a few accidents due to loading holes too soon after springing. Some of these are due to pouring black powder in on smouldering pieces of fuse. Sprung holes should always be blown out when possible. Also it is a simple matter to let a tamping stick or scraper stand in a sprung hole for a few minutes to see if the end gets warm.

The improper making of primers claims a few victims every year. One man in England was badly injured by trying to waterproof a blasting cap with candle grease. While making primers the wearing of open lights in a man's hat should be absolutely prohibited as a spark or drop of hot candle grease falling on the detonator under these conditions rarely fails to cause a serious accident.

In the United States there is always a large number of accidents caused by people, children in particular, playing with explosives and detonators. Those connected with explosives proper occur mostly in connection with the celebration of the "Glorious Fourth."

The number of accidents due to playing with blasting caps in the United States is enormous (71 during 1910), when compared with other countries. The usual course pursued by a child upon finding a blasting cap is to try and extract the contents with a pin or nail, to make a pencil tip, hold a lighted match to it or pound it with a rock or hammer to see what will happen. In doing these no chances are taken, the result being a "sure thing," the only variation being in the number of fingers lost. While these accidents are rarely fatal in England, the superior ingenuity of the American boy in devising amusements with blasting caps resulted in 10 deaths during the year 1909. In 1910 only one was killed in this manner. Practically all of these accidents are due to criminal negligence on the part of people who leave blasting caps where children can find them.

Three accidents may be mentioned here, one showing the unreliability of newspaper accounts, and the other two the danger of employing explosives for other than their legitimate purpose. It was reported that a man held in his hand a stick of dynamite with a blasting cap and fuse. While attempting to insert the fuse in the cap, the cap exploded setting off the dynamite in his hand which in turn set off some dynamite stored in a shanty near where he was standing. The shanty was wrecked and the man knocked down but was not injured. This was said to have occurred at Waupaca, Wis., on June 15th, 1905. On May 20th, 1906, some Italians were playing cards near Trenton, N. J. One of them placed a stick of dynamite under one leg of the table to steady it. Later an Italian showed his great delight at holding a winning hand by hammering on the table with his fist. When the smoke had cleared away the enthusiast was discovered to be "shy" an arm, his companions bruised to a greater or less extent. The following is reported from Lusted, Oregon, April 5th, 1905: A man in order to kill his dog tied him to a tree, fastened a cartridge of dynamite to him, lighted the fuse and ran. Not wishing to spoil good rope or chain the dog was tied with an old piece of rope, so that when the man ran the dog broke loose and followed him. The man fled to his house and frantically threw boots, flat irons, stove lids and various household utensils at the dog to drive him away. The dog to avoid this storm retreated beneath the house where the dynamite exploded doing considerable damage to the house.

CONCLUSIONS.

In regard to the prevention of accidents with explosives, the first rule to be observed is to keep explosives and detonators apart until necessary to use them. In regard to preventing accidents in storage, it is best to have separate magazines for explosives and blasting supplies. The ground around a magazine should be carefully cleared to prevent any brush fires from communicating with it. The walls and roof should be constructed of uninflammable materials. Where large quantities of explosives are stored it is a very simple matter to make magazines bullet proof by having double walls with not less than an 8-inch space between them, this space to be filled with coarse sand or gravel. Coarse sand is more effective than fine, also angular grains are better than round. No person should be permitted to enter a magazine carrying matches or while smoking. Inflammable materials such as oils, etc., should never be stored with explosives.

Nothing can be more effective for the prevention of accidents in transportation than a close regard for the rules laid down by the "Bureau for the Safe Transportation of Explosives." These can be procured from any railroad.

To prevent accidents in the thawing of dynamite always keep the cartridges lying on their sides at temperatures not to exceed 80 to 90 degrees Fahrenheit, the lower temperature being best. Never thaw explosives on shelves or racks directly over the source of heat. Never thaw dynamite on heated stoves, rocks, bricks or metal, nor in an oven, and never thaw dynamite in front of, near or over a steam boiler or fire of any kind. Don't place a hot water thawing can over a fire and never put dynamite in hot water or allow it to come in contact with steam.

To prevent accidents in the use of explosives, requires the exercise of plain common sense. The practice of miners wearing lights in their hats or smoking while making primers and preparing charges cannot be condemned too strongly. It is nothing but criminal negligence. Any attempt to use frozen dynamite should be prohibited and the drilling out and tampering with misfires is extremely dangerous. Most miners do not realize that very few men have a chance to reform after their first accident with explosives. Where a charge apparently misses no return should be made to the place within an hour. As in cases of this kind it is necessary to draw an arbitrary line, the writer means not less than sixty minutes. In loading charges nothing but wooden tamping rods should be used. When drilling new holes near unexploded charges the greatest care should be taken to point the new hole in direction that will prevent any possibility of the bit striking the explosive in the missed hole. Blasting caps should never be left where children can find them. In short, if users of explosives will only realize what they are doing, accidents would be reduced about ninety per cent.

The following tables give statistics of accidents in general and in particular the use of explosives in the United States and Great Britain. They also show the accidents occurring with the different kinds of explosives. A study of these tables will show not only what kind of explosives are the most liable to be in accidents but what operations can be considered the most dangerous:

TABLE I.

*Showing all accidents with explosives in the United States for 1910 grouped under the several heads of Storage, Transportation, Use and Miscellaneous Use.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons			
		Killed	Inj'r'd		
Storage	25	62	94	25	50
Transportation	2	1	4	5	7
Use	379	339	508	42	421
Miscellaneous Use	173	13	208	7	180
TOTALS	579	415	814	79	658

* Du Pont annual report for 1910

TABLE II.

*Showing all accidents in the Keeping, Conveyance, Use and Miscellaneous in the United Kingdom during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons			
		Killed	Inj'r'd		
Keeping	9	3	11	2	11
Conveyance	....	..	...	..	....
Use and Miscellaneous	373	57	406	1	374
TOTALS	382	60	417	3	385

*Report of His Majesty's Inspectors of Explosives for 1910.

TABLE III.

*Showing total number and nature of accidents shown in Table I, caused by each description of explosives in the United States as compiled from newspaper clippings for 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons			
		Killed	Inj'r'd		
Dynamite	266	251	345	35	301
Fuse	0	0	0	0	0
Ammunition	31	9	29	2	33
Black Powder	85	55	135	6	91
Fireworks	8	1	9	12	20
Gunpowder	20	5	22	2	22
Smokeless Powder	4	20	10	0	4
Guncotton	0	0	0	0	0
Nitroglycerine	10	10	6	7	17
Blasting Caps	97	2	140	2	99
Railroad Torpedoes	12	0	16	0	12
Dynamite and Black Powder	1	0	1	3	4
Flashlight Powder	4	1	25	0	4
**Unspecified	41	66	76	10	51
TOTALS	579	420	814	79	658

*Du Pont annual report for 1910.
**This large number is due to incomplete details given in the newspapers.

TABLE IV.

*Showing total number and nature of accidents caused by each description of explosives in the United Kingdom during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons			
		Killed	Inj'r'd		
Black Powder Class	162	15	176	12	174
Dynamite	174	38	166	20	194
Chlorate Mixture	16	4	15	2	18
Fulminate	5	1	5	1	6
Ammunition and Miscellaneous	8	2	7	0	8
Fuse	2	0	2	0	2
Detonators	33	0	40	6	39
Fireworks	5	5	10	1	6
Unknown	2	1	1	1	3
TOTALS	407	66	422	43	450

*Report of His Majesty's Inspectors of Explosives for the year 1910 Revised to American Standards.

TABLE V.

**Showing the total number and nature of accidents in the Transportation of the different kinds of Explosives in the United States during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons			
		Killed	Inj'r'd		
Dynamite	0	0	0	2	2
Dynamite and Black Powder	0	0	0	1	1
Fireworks	1	1	0	1	2
Black Powder	0	0	0	1	1
Smokeless Powder	1	0	4	0	1
TOTALS	2	1	4	5	7

*Du Pont annual reports for 1910.

**There were no accidents reported in the "Conveyance" of Explosives in the United Kingdom during the year 1910.

TABLE VI.

*Showing the total number and nature of accidents in the Use of the different Explosives in the United States during the year 1910.

Summary	Accidents causing loss of life and bodily injury			Accidents not causing loss of life and bodily injury	Total No. of Accidents
	No. of Accidents	No. Persons			
		Killed	Inj'r'd		
Dynamite	217	210	239	22	239
Black Powder	71	36	114	2	73
**Unspecified	34	57	52	5	39
Gunpowder	10	2	9	0	10
Blasting Caps	21	1	48	1	22
Nitroglycerine	6	5	5	3	9
Smokeless Powder	3	20	6	0	3
Flashlight Powder	3	1	24	0	3
Fireworks	8	2	6	3	11
Ammunition	9	7	6	0	9
Railroad Torpedoes	1	0	1	0	1
TOTALS	383	341	510	36	419

*Du Pont annual report for 1910.

**This large number is due to incomplete details given in the newspapers.

TABLE VII.

*Showing detail of accidents classified in Table VI.

Summary	Accidents Causing Loss of Life and bodily Injury			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons			
		Killed	Injured		
DYNAMITE—					
Thawing	24	31	22	4	28
Premature and Delayed Explosions	106	114	106	4	110
Tamping and Loading	5	3	4	0	5
Striking Overlooked Charges	29	9	38	0	29
Drilling out Unexploded Charges	8	7	15	0	8
Overcharges	6	2	7	12	18
No Details	31	30	20	0	31
Hit by Rock	1	5	10	0	1
Sparks, Flames, etc	4	3	3	2	6
Fumes	1	3	12	0	1
Careless Handling	1	1	0	0	1
Lightning	1	2	2	0	1
BLACK POWDER—					
Sparks, Flames, etc	26	14	50	0	26
Premature and Delayed Explosions	24	9	41	0	24
No Details	14	7	14	2	16
Opening Keg with Pick	2	2	1	0	2
Striking Overlooked Charges	2	4	1	0	2
Contact with Mine Trolley Wire	1	0	4	0	1
Drilling Out Unexploded Charges	1	0	1	0	1
Overcharges	1	0	2	0	1
UNSPECIFIED EXPLOSIVES—					
Overcharges	8	3	8	5	13
Premature and Delayed Explosions	18	13	32	0	18
No Details	6	41	5	0	6
Sparks, Flames, etc	2	0	7	0	2
GUNPOWDER—					
Sparks, Flames, etc	2	0	2	0	2
No Details	8	2	7	0	8
BLASTING CAPS—					
No Details	14	1	36	1	15
Premature and Delayed Explosions	2	0	2	0	2
Run Over by Wagon	1	0	1	0	1
Striking Overlooked Charges	2	0	2	0	2
Sparks, Flames, etc	2	0	7	0	2
NITROGLYCERINE—					
Striking Overlooked Charges	2	1	1	0	2
No Details	1	1	0	3	4
Premature and Delayed Explosions	3	3	4	0	3
SMOKELESS POWDER—					
No Details	2	8	1	0	2
Premature and Delayed Explosions	1	12	5	0	1
FLASHLIGHT POWDER—					
No Details	1	1	21	0	1
Premature and Delayed Explosions	2	0	3	0	2
FIREWORKS—					
No Details	5	2	3	0	5
Sparks, Flames, ete	1	0	1	2	3
Premature and Delayed Explosions	2	0	2	1	3
AMMUNITION—					
No Details	5	2	3	0	5
Premature and Delayed Explosions	3	5	2	0	3
Burst Guns	1	0	1	0	1
RAILROAD TORPEDOES—					
Run Over by Mine Car	1	0	1	0	1
TOTALS	383	341	510	36	419

*Du Pont Annual Report for 1910.

TABLE VIII.

*Showing total number and nature of accidents occurring in the Miscellaneous Use of different explosives in the United States for the year 1910.

Summary	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss of Life or Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons			
		Killed	Injured		
Dynamite	36	5	45	2	38
Gunpowder	9	3	9	0	9
Blasting Caps	76	1	92	1	77
Ammunition	22	2	23	1	23
Black Powder	11	1	15	0	11
Unspecified	4	1	4	3	7
Railroad Torpedoes	11	0	15	0	11
Flashlight Powder	1	0	1	0	1
Nitroglycerine	1	0	1	0	1
Fireworks	2	0	3	0	2
TOTALS	173	13	208	7	180

*Du Pont Annual Report for 1910.

TABLE IX.

*Showing the Details of the Accidents Classified in Table VIII.

Summary	Accidents Causing Loss of Life and Bodily Injury.			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons			
		Killed	Injured		
DYNAMITE—					
Thrown into fire	11	3	17	1	12
Left in coal	0	0	0	1	1
Playing with	24	2	27	0	24
Shooting at	1	0	1	0	1
GUNPOWDER—					
Playing with	7	2	7	0	7
Thrown into fire	2	1	2	0	2
BLASTING CAPS—					
Playing with	70	1	86	1	71
Thrown into fire	5	0	5	0	5
No details	1	0	1	0	1
AMMUNITION—					
Playing with	13	2	11	0	13
Thrown into fire	9	0	12	1	10
BLACK POWDER—					
Cleaning out chimneys	1	0	1	0	1
Playing with	7	1	11	0	7
Thrown into fire	3	0	3	0	3
UNSPECIFIED EXPLOSIVES—					
Playing with	3	1	3	1	4
No details	0	0	0	2	2
Burst guns	1	0	1	0	1
RAILROAD TORPEDOES—					
Playing with	10	0	14	0	10
Run over by car	1	0	1	0	1
FLASHLIGHT POWDER—					
Thrown into fire	1	0	1	0	1
NITROGLYCERINE—					
Thrown into fire	1	0	1	0	1
FIREWORKS—					
Thrown into fire	1	0	1	0	1
No details	1	0	2	0	1
TOTALS	173	13	208	7	180

*Du Pont Annual Report for 1910.

TABLE X.

*Showing the total number and nature of accidents in the Use of different explosives and under Miscellaneous Circumstances in the United Kingdom during the year 1910.

Summary	Accidents Causing Loss of Life and Bodily Injury			* Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons			
		Killed	Injured		
Black Powder Class	155	13	167	..	155
Dynamite	165	35	177	..	165
Chlorate Mixture	15	3	14	..	15
Fulminate	1	..	1	..	1
Ammunition.	2	..	2	..	2
Fuse	2	..	2	..	2
Detonators	29	..	35	1	30
Fireworks	2	4	7	..	2
Unknown	2	1	1	..	2
TOTALS	373	57	406	1	374

*Report of His Majesty's Inspectors of Explosives for the year 1910, Revised to American Standards.

TABLE XI.

*Showing details of accidents in the Use of Explosives and under Miscellaneous Circumstances in the United Kingdom during the year 1910. (Details of Accidents shown in Table X.)

Summary	Accidents Causing Loss of Life and Bodily Injury			Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
	Number of Accidents	No. of Persons			
		Killed	Injured		
BLACK POWDER CLASS—					
Prematures and failing to get away on time	18	1	18	....	18
Firing by electricity when persons are at shot hole	3	..	3	....	3
Not taking proper cover	22	4	20	....	22
Projected debris	7	..	7	....	7
Hang fires and returning too soon to shot hole	16	1	16	....	16
Tampering with missed shots	5	..	5	....	5
Loading and tamping the charge.	15	2	17	....	15
Sparks, flame, etc	57	..	62	....	57
Boring into unexploded charges	2	..	2	....	2
Striking unexploded charges in removing debris	..	..	..	....	..
Preparing charges	1	..	1	....	1
Lighting fuse before inserting charge	1	..	1	....	1
Loading too soon after springing hole	7	4	5	....	7
Various	..	..	..	....	..
DYNAMITE					
Premature and failing to get away on time	8	3	7	....	8
Firing by electricity when persons are at the shot hole	7	1	6	....	7
Not taking proper cover	39	5	37	....	39
Projected debris	21	..	21	....	21
Hang fires and returning too soon to shot hole	23	4	24	....	23
Tampering with missed shots	8	2	8	....	8
Tamping and loading the charge	19	5	16	....	19
Sparks, flame, etc	..	..	..	....	..

TABLE XI. (Continued)

Summary	Accidents Causing Loss of Life and Bodily Injury: Number of Accidents	No. of Persons: Killed	No. of Persons: Injured	Accidents Not Causing Loss of Life and Bodily Injury	Total No. of Accidents
Boring into unexploded charges...	20	6	23	....	20
Striking unexploded charges in removing debris	9	6	15	....	15
Preparing charges	2	..	3	....	2
Lighting fuse before inserting charge	..	..	..	....	..
Loading too soon after springing	..	..	..	....	..
Various	3	1	3	....	3
CHLORATE MIXTURES					
Prematures and failing to get away on time	..	..	..	....	..
Projected debris	6	..	6	....	6
Hang fire and returning too soon to shot hole	1	..	1	....	1
Tampering with missed shots	1	..	1	....	1
Boring into unexploded charges	1	..	1	....	1
Loading too soon after springing	1	1	..	....	1
Loading and tamping	2	..	3	....	2
DYNAMITE AND BLACK POWDER					
Premature and failing to get away in time	1	..	1	....	1
Tampering with missed shots	1	..	2	....	1
CHLORATE MIXTURES AND BLACK POWDER					
Prematures and failing to get away in time	1	1	..	....	1
Tampering with missed shots	1	1	..	....	1
DETONATORS					
Hang fires and returning too soon	1	..	1	....	1
Sparks, flame, etc	1	..	1	1	2
Striking unexploded charges in debris	4	..	4	....	4
Preparing charges	5	..	5	....	5
Various	4	..	4	....	4
FUSE					
Various	1	..	1	....	1
MISCELLANEOUS					
Playing with detonators	13	..	19	....	13
Playing with other explosives	4	..	4	....	4
Destroying explosives	2	1	8	....	2
Explosives in coal	5	1	3	....	5
Illegal Manufacture	1	..	3	....	1
Thawing	2	4	10	....	2
Fireworks display	1	3	7	....	1
Firing a maroon	1	1	..	....	1
Shell	1	..	1	....	1
TOTALS	373	57	406	1	374

*Compiled from the "Report of His Majesty's Inspectors of Explosives for 1910."

NOTES ON TABLE XI.

Details of Accidents in the Use of Explosives in the United Kingdom in the Year 1910.

9 premature shots with black powder were fired by means of squibs.

2 hang fire shots with black powder were fired by means of squibs.

2 accidents were caused by twisting a copper needle in a hole loaded with black powder in preparing it to be shot by means of squibs.

2 accidents were caused by using a steel drill to remove obstructions from holes being loaded with black powder.

3 accidents were caused by tamping charges of black powder with steel rods.

4 accidents were caused by tamping charges of black powder with copper or bronze rods. In 1909 there were 7 accidents with copper tamping rods.

3 accidents were caused by tamping dynamite with copper rods and 1 with an iron rod. In 1909 there were 6 accidents with copper and 1 with steel tamping rod.

8 accidents were caused loading and tamping frozen nitroglycerine explosives.

90 per cent of the accidents from sparks and flames in the presence of black powder were due either to the miners wearing open lights in close proximity or men smoking.

2 accidents caused by men trying to force a nail into a frozen dynamite cartridge in making primers.

1 accident was caused by the violent handling of a cartridge of frozen dynamite.

TABLE XII.

*Showing average annual number of accidents in the use of explosives in the United Kingdom from each cause for the five years ending with 1910:

Premature and failing to get away from shot hole	25
Firing by electricity when persons are at the shot hole	11
Not taking proper cover	28
Projected debris (two years)	32
Hang fires and returning too soon to shot hole	40
Tampering with missed shots	22
Tamping and loading the charge	45
Sparks, Flame, etc.	72
Boring into unexploded charges	12
Striking unexploded charges in removing debris	23
Preparing charges	5
Lighting fuse before inserting charge	1
Fumes	1
Loading too soon after springing the hole	11
Various	4

*Report of His Majesty's Inspectors of Explosives for 1910.

THE RELATION OF THE MINING INDUSTRY TO THE PREVENTION OF FOREST FIRES.

BY THOS. B. WYMAN, MUNISING, MICH.

It is a pleasure to again have an opportunity to appear before the Lake Superior Mining Institute and an even greater pleasure to note that the program shows the names of men standing so high in the ranks of their professions that you are sure of receiving a wealth of valuable thought and suggestion even though my own contribution be of a simple nature.

In the title of my so-called paper I have indicated that certain relationships exist between the mining interests and the prevention of forest fires. At first thought this relationship seems very remote if, indeed, it can be said to exist at all, and I may first have to offer evidence of kinship in order to warrant further procedure.

The "Mining interests" are broad, so broad that they include not only the corporate and private explorations, developments and established mines, but the men engaged in daily work within the mines and for the mines. In the wonderful ramifications of the industry, the matter of supplies, of power, of transportation, of technical and legal education, etc., all have important places and each is linked to the others by threads which become stronger as the development of the industry becomes more intense. For our mines we must look to Mother Earth; for our supplies and power to the same source. Transportation can be had only at the expense of natural supplies, and for the many derivatives of human ingenuity, which advance the industry, direct tracings can be had to the things of nature.

It is, then, indisputable that mining is dependent upon the

Secretary-Forester Northern Forest Protective Association.

earth and upon the natural earthy assets, and the forest is the greatest visible, natural asset known to the world. There are hundreds of thousands of uses to which the forest has been advantageously put and one of the most important has been the development of your industry. It is recognized that the mining interests depend to a large degree upon the forests and, this being so, the safety and continuance of forest assets is of the greatest import. Granted safety and perpetuation the forest will supply to thousands of industries the necessities of progress. Remove safety and allow destruction to timberlands and dependent industries will be demoralized and die. Danger to the forest does not lie in harvesting wood fibre either for the mill or the mine. Danger does not lie in the failure of seed crops and resultant young growth. Danger does not lie in the fact that it takes years to develop a marketable crop of timber. The real danger to forests—seeds, seedlings, saplings, polewoods and standards of softwoods, and hardwoods alike—is from fire.

The statement has been made many times that fire destroys more timber annually than is cut by the lumberman. So, when it is considered that upon the basis of an annual cut of fifty billion feet at an estimated average stumpage of $3.00 per thousand, the value exceeding $150,000,000 per year, the loss to the nation is very apparent. This general loss is felt directly by every timber using industry, not immediately, unless the fire destroys forests from which supplies are being received, but by doubling the annual harvest the length of time which the present supply will last is halved. Again, every fire prepares the way for succeeding fires by partially consuming the material and leaving the balance in a highly inflammable condition. Young growth, coming in from natural seeding among this blackened and burnable materials, is exposed to a serious risk for many years and will, in all probability, be lost before reaching marketable size.

Seed trees, injured by burning, are unable to bear heavy seed-crops and those few seeds which are borne, scattered and germinate may be lost. Had it not been for fires we would not have an acre of barren plain land, for our yearly operations have not been of such magnitude but that natural seeding would have taken place and covered the soil with species of value to you in your industry. Stull timber and lagging would be abundant and obtainable at minimum cost; mine poles and ties would command a price consistent with the available supply. All could be obtained from territory logged off years ago, where the so-called "logging chance" was of the best and the logging cost extremely low. There is no delight in operating a bottomless swamp for tamarack, spruce and cedar, building corduroy roads or breaking down the snow into the mud so it will freeze and give bottom for the winter haul. There is delight in operating level lands, where roads can be rightly and easily planned and constructed, where the haul can be made by sleigh or by railroad, and where immediate repossession of the area can be had by seeding pines and hardwoods.

To you, who own lands suited to the growth of timber, but which are not of agricultural value, this immediate repossession of surface is important for each year's growth is a year nearer the harvest, a year of taxation saved, and a year in which investment in soil value is a producing investment instead of a losing venture. Can you think of a more simple way of turning a non-producing investment into a thing of ultimate worth, than by protecting against fire at a cost too immaterial to be seriously considered as a hindrance? Can you conceive of any department of your mine running on, year after year, losing money, tying up capital, when by spending from one-fifth to one-half of one per cent you could turn it to a department of conceded value? Most of you have a department of the nature mentioned. I do not say it critically, but simply because you have likely considered that the well has already been drained, when in reality, there is a spring from the solid rock of nature which will refill it in due time if permitted to do so.

Forest protection, of which fire prevention is ninety-nine per cent, costs from one and one-half cent to three cents per acre depending upon conditions; two cents is considered a reasonable average cost and when spent judiciously the protection should be very efficient. Efficient protection can be had only through cooperation, education and organization. Cooperation should consist in mutual help, in a mutual understanding of forestal policies, in mutual efforts toward needed legislation. Educational activities should be extended in every direction; every medium used, every individual approached to the end that the great menace may be fully understood and, by personal appreciation, combated. Organization necessitates a banding together of all who own timber, to put into the field active preventive forces.

It was my privilege to appear before this body on a previous occasion, some few years ago, and at that time I advocated the formation of a protective association designed to give the protection which should be furnished through taxation. *At this time I am glad to say that just such an organization is actively patrolling the timber lands of the Upper Peninsula —many of you are members. Its work is being recognized and its efforts are meeting with success.

The Northern Forest Protective association has today, a listed area of 2,000,000 acres, and is patrolling over five million acres. It has eighteen fire wardens in the field posting notices, influencing settlers, woodsmen, hunters, fishermen, section crews, campers and berry pickers. It is cooperating with the State and National Governmental Forest Departments. It has secured concessions from the United States Postoffice Department and is now putting up appropriate notices in the three thousand postoffices of the states of Michigan and Wisconsin. The serious fires of the Lower Peninsula have proven the absolute need of organized effort and I trust that the timber holders of that section will either become members of our association or organize a similar one of their own.

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*Ref. Paper by Mr. Wyman, "How Reforestation May Be Applied to the Mine Timber Industry," Vol. XIV, 1909, pp. 116-130.

We have been fortunate this season in having frequent rains which have given us favorable conditions under which to perfect our organization and our fire risk has been lessened by them. But with the same conditions existing as were prevalent at Oscoda and Au Sable, I believe that fires could not gain the headway here which caused such great destruction because, with the appreciation of the possible results which is now held by our people, it is safe to presume that someone, probably many, would assume the duty of preventing loss to others by early attack and control. If my surmise is correct you, who own surface improvements and timber, can begin to rest in peace for history has proven that destructive fires are the outcome of small fires, unheeded until the proper conditions of drought and wind have fanned them into a furnace. When every resident of and visitor to our Upper Peninsula will make it his business to quench any fire he may see there will be little to fear.

You may be interested to learn somewhat of the proportionate origin of forest fires and I desire to give you the figures in order that your influence may be directed towards the source of greatest danger. A number of state and association reports were consulted in arriving at this average and the figures are somewhat surprising. Settlers, clearing land, burning brush, etc., cause 45 per cent of all fires. You can surely influence the settlers of your community to greater care. Sparks and live coals from locomotive stacks are charged with 28 per cent, a very high proportion when one considers that the state law provides that efficient spark arresters must be used. Campers, fishermen, and hunters have 7 per cent marked against them and the causes of 25 per cent of fires are unknown. Of this latter percentage let us make a guess. By a course of elimination we can say with reasonable accuracy that none of the unknown causes are the settlers' fires, for evidence of such always exists. In the same way nearly every fire originating from railroads can be properly placed and the percentage of unknown origin still remains at 25. Let us say, to be liberal that 5 per cent are traceable to lightning, an unwarranted assumption, and that of the 20 per cent remaining 10 per cent are from miscellaneous causes—where will we place the other 10 per cent? Our experience gives us the right to say that the smoker can stand 10 per cent and be let off rightly. Ten per cent of all forest fires traceable to the man with the pipe, cigar and cigarette, and, of course, the match.

Let me ask how many smokers, of your own number, if you will, ever make it a point to see that your match is out before throwing it aside? I am not trying to fasten blame to any individual but I am fastening the blame for 10 per cent of our fires to a habit, which can be and needs be overcome. Summing up, we have charged but 5 per cent of the whole to uncontrollable causes; there remains 95 per cent chargeable to controllable causes, which, since they were not controlled, must be the result of carelessness.

It was carelessness, due to familiarity with small fires, that resulted in the loss of over four hundred lives and destroyed eleven equipped mines in the Porcupine region of Ontario. Woodsmen and miners, familiar with possible results, allowed many small fires to burn without hindrance until, fanned by terrific winds, they were united into one vast furnace which swept all before it. Miners employed by mining corporations allowed these fires to destroy the property of their employers without making an effort toward protection, until too late. Does this not indicate a distinct need of complete understanding between employer and employee? Is it not a relationship between your interests and the prevention of a menace which threatens them? You encourage your employes to take a few days off, hunting or fishing. They go to your lands, into your timber, through your fields. Are they thoughtful of your interests? Do they put their camp fires out? Do they dump the heel of that pipe of Peerless in a safe place, or wherever the thought strikes them? Do they refrain from smoking when in dangerous localities? I ask you these questions because as their employers, you should know.

Your woodsmen, cruisers, exploring parties, compassmen and others who visit your timberlands, have occasion to observe and report, or better to put out incipient fires. Are your files teeming with such reports? I trust that they are and that action has been swift.

As conditions are, relationships exist between employer and employe, between lawyer and client, between retailer and customer, among families, among secret orders, among community dwellers. So long as our conditions remain dormant you must recognize this relationship, this dependence upon those who serve you and are bound to you. But the thing for which we must all stand—all strive with constant zeal is a relationship characterized by the desire of every man to safeguard every other man and every other man's property.

James Mine, Iron River, Mich.

Penn Iron Mining Co., Hydro-Electric Plant, Sturgeon Falls, Menominee River, Showing Dam and Spill-way.

Clam Bake at Sunset Lake, Iron River, Mich.

Crystal Falls, Mich.

BLOCK CAVING AND SUB STOPE SYSTEM AT THE TOBIN MINE, CRYSTAL FALLS, MICH.

BY FRED C. ROBERTS, CRYSTAL FALLS, MICH.

The systems of mining used at the Tobin Mine were arrived at after trial of several methods, each of which proved more or less unsuitable to the peculiar nature of the ground to be mined.

Underhand stoping was tried, but soon discontinued on account of the continual falling of ground from the back of the stope. Back-stoping was next tried, but the danger from falling ground was still too great. Sub-stoping was the third method used, and in some parts of the mine proved satisfactory, and is still used to some extent where the ore body is too narrow or of too firm a nature to be mined by the block caving system. Block caving was the next method used, and proved so well adapted to the conditions and physical characteristics of the ore that it has been adopted as the principal means of mining.

The levels at the Tobin are 125 feet from floor to floor, and the main haulage drift follows very closely the hanging wall.

In the block to be mined by caving, parallel cross-cuts, 24 feet from center to center, are driven from the main drift, as nearly at right angles as may be, to the foot-wall, and are connected at the foot-wall side by a small drift for ventilating purposes. Throughout the length of these cross-cuts, chute-raises are put up alternately on the right and left sides at intervals of 15 feet, to the sub-level 25 feet above. (Fig. 1).

The sub-level is opened 25 feet above the back of the main level. A drift is driven, parallel with and about 15 feet from the hanging wall, the entire length of the block to be mined. Cross-cuts are driven to the foot-wall from this sub-level drift directly above the cross-cuts on the main level. Opposite each cross-cut on the sub-level a raise inclined about 45 degrees is put up from the sub-drift to the hanging wall,

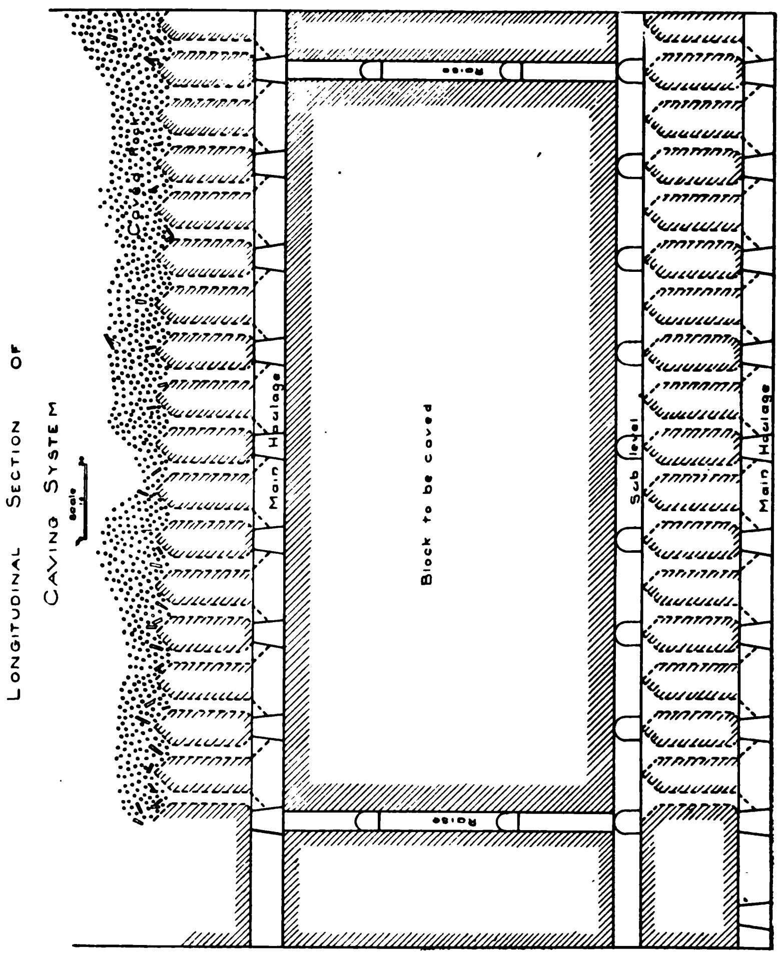


FIG. 1

the object being to leave an additional thickness of back above the main haulage drift. The cross-cuts on the sub-level are connected every 15 feet by drifts over the line of chutes, leaving small pillars of about 10 ft.x16 ft. It is sometimes necessary to cross-cut these small pillars again, depending upon the nature of the ground. A drift is also driven along the foot-wall connecting all the cross-cuts. (Fig. 2).

After the pillars have been reduced to a suitable size,

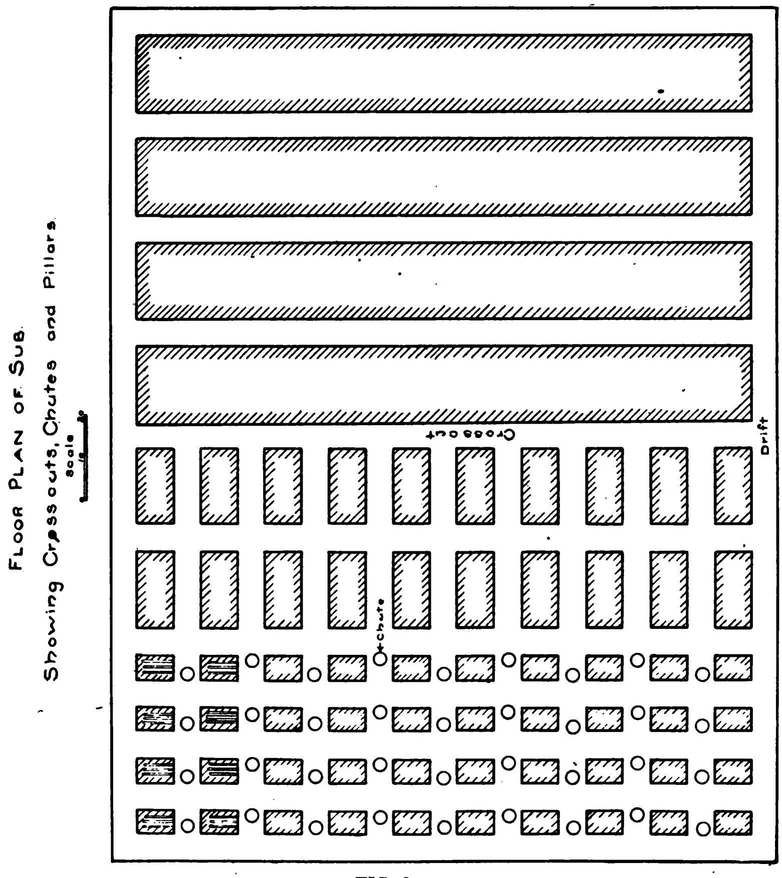


FIG. 2

they are drilled with a sufficient number of holes so that they may be all blasted at once. The pillars furthest from the man-way being drilled first. Holes are also drilled around the tops of the chute-raises and blasted, making the raises funnel-shaped at the top. At the ends of the block to be caved, it is necessary to weaken the ground so that it will cave square with the pillar. Raises are put up from the end cross-cuts at varying intervals, depending on the nature of

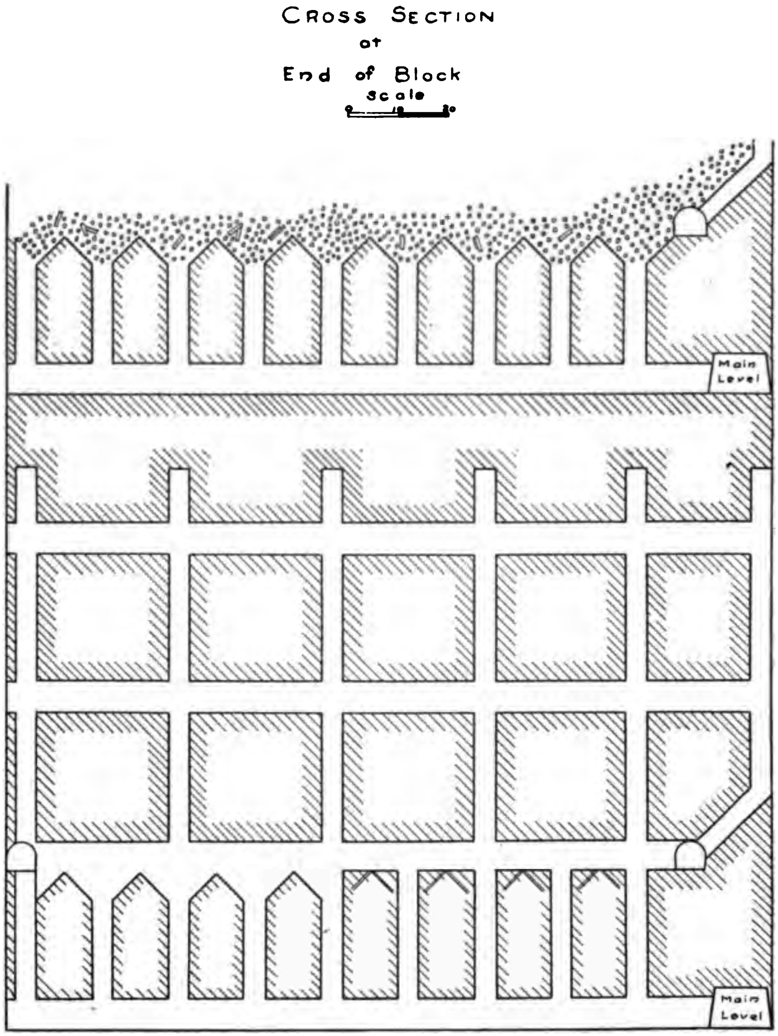


FIG. 3

the ground. These raises are connected by two cross-cuts 25 and 50 feet respectively above the sub-level. (Fig. 3).

After all the necessary raising, drifting, and cross-cutting have been completed, the holes in the pillars of the sub-level are all blasted at once, undercutting the entire block, which settles down on the back of the level below. The ends of the block not being entirely cut off from the pillar, the ore does not drop down in one solid block, but breaks up in settling

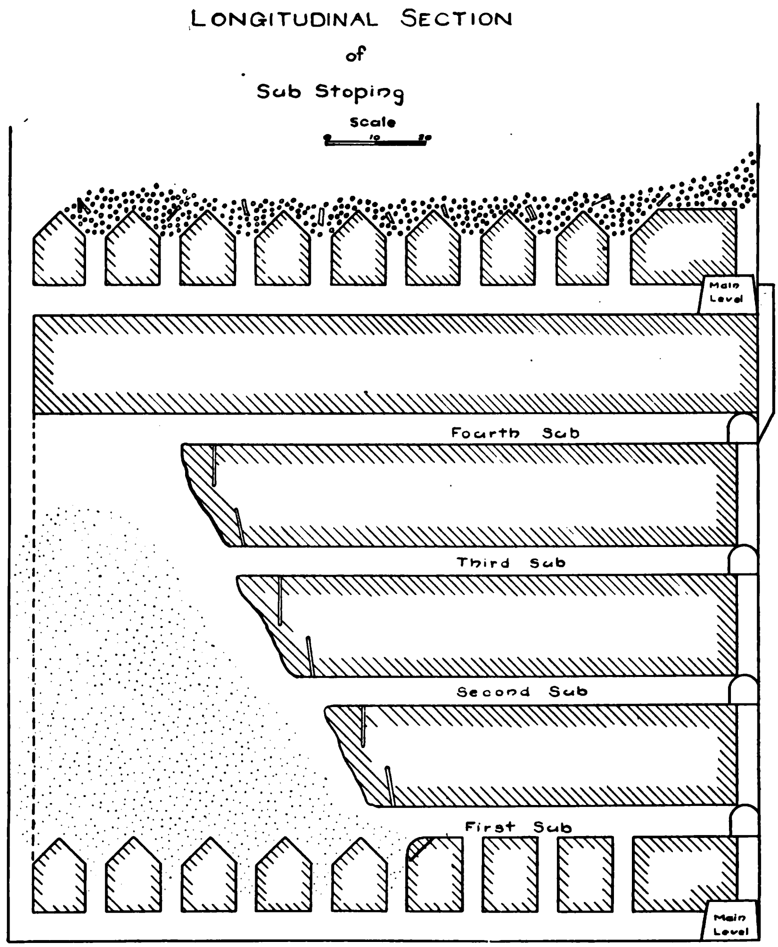


FIG. 4

and comes down in such shape that it can be handled through the funnel shaped chute-raises with only occasional blasting of masses that lodge in the chutes. The caved ore is drawn uniformly throughout the level, so that it will settle down evenly, and this keeps the caved rock from the old level above from getting mixed into the ore. For this method of handling the block-caving system, as far as known to us, we are the originators. (Fig. 4).

Sub-stoping is used where caving is not practical; at the narrow ends of the ore body, and in pockets and smaller deposits that are sometimes found separated from the main body. Conditions vary so in these cases, that they have to be met in different ways. The nature of the ground and dimensions of the ore body have to be taken into consideration in each case, and the method of mining adapted to it.

The usual method of working these places is to drive a drift on the main level the entire length of the ore body in question, and determine the width of the same by cross-cuts. Chute-raises are put up at intervals of about 15 feet. From a raise, at the end of the ore nearest the shaft, a sub-level is opened 15 feet above the main level. This sub-level consists of a drift the length of the ore and connected at the far end with a raise from the main level. Second, third, and fourth subs are opened in a similar manner above the first, twenty feet being the usual distance from the back of one sub-level to the floor of the next above. The raise at the far end of the ore is carried through to the upper sub.

All preliminary development work being completed, stoping is begun at the far end of the ore on the lower sub-level. Upper and underhand holes are drilled and blasted around the raise which connects all the subs at the far end. The ore thus broken falls into the chute at the bottom of the raise. This is repeated until the lower sub is drawn back 12 or 15 feet. (Fig. 5) when the miners on the second sub begin stoping in a similar manner to that done on the first sub. The second sub having been drawn back to a safe distance, the third sub stope is begun. In this way each gang of miners is always working under solid ground and far enough back to escape falling ground from the stopes above.

The width of stope that can be carried this way depends upon the nature of the ground. In the Dunn and Great Western mines where the ground was exceptionally firm, with a strong capping above, stopes were worked out 80 feet

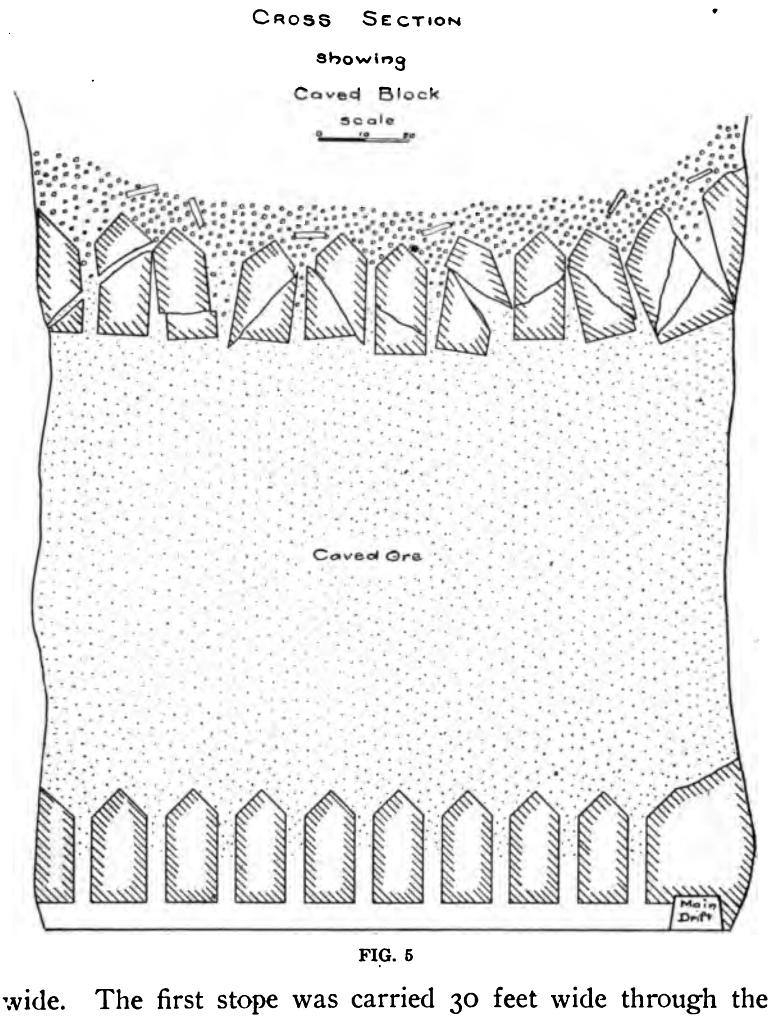


FIG. 5

wide. The first stope was carried 30 feet wide through the middle of the ore, beginning at the far end and drawing back. Benches (Fig. 6) were then cut at each sub-level the entire length of the ore pillar on each side of the stope. These benches were cut into the pillar far enough to protect the men from falling ground from the others working above. Beginning at the far end and drawing back, these benches were stoped out by upper and underhand holes, the broken ore falling into the open stope. The process was repeated to remove the remaining ore in the pillars.

DISCUSSION.

F. W. SPERR—Mr. Roberts' reference to the necessity of drawing off the ore uniformly, is a consideration of the high-

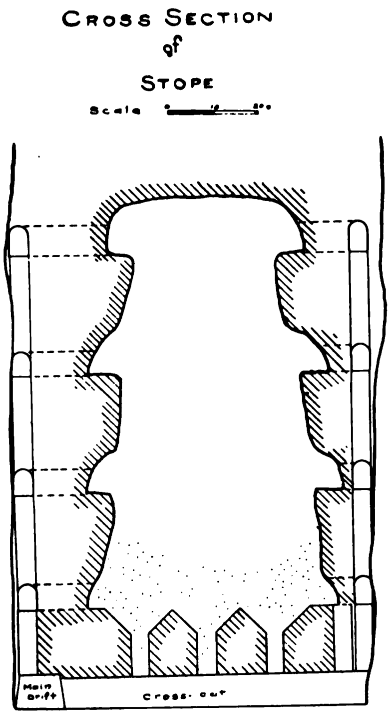


FIG. 6

est importance in the block-caving method; for, if ore should be drawn from one chute continuously without drawing any from the surrounding chutes, a vertical pipe of material with a diameter about equal to that of the bottom of the chute would move downward all the way from surface. If a large unbroken block of ore obstructs the vertical passage, a hole will work itself out to one side, forming a new chute to continue its way upward to surface or to the bottom of another large piece, making a devious, narrow path for the material to pass through. The overburden of sand or other waste material will appear at the bottom before any ore comes in from the sides. The gathering in from the sides always begins at the top. But, if all the chutes are drawn evenly, the whole mass of ore will settle evenly, and the overburden will follow without mixing with the ore.

THE CORNWALL, PA., MAGNETITE DEPOSITS.

BY E. B. WILSON, SCRANTON, PA.

That there has been considerable speculation over the genesis of the Cornwall magnetite deposit in Lebanon County, Pa., is due to its structure, composition, and geological surroundings differing materially from the magnetite deposits of New Jersey and New York.

Persifor Frazer, Jr.,* in Vol V. of the Transactions of the American Institute of Mining Engineers, says: "It is not quite certain how much of the magnetic particles with which these ores are mixed may have come from the trap itself. * * * It is likely that much is to be ascribed to this source; but, however that may be, it cannot but be of the greatest significance that the two plates of trap which occur near these mines inclose or cover the greater number of producing deposits."

The foot-wall of the Cornwall ore deposit is trap rock approximating basalt, that forms a kind of basin in which the ore is found. The hanging wall or cover immediately above the ore to the south of Middle Hill mine is limestone, and through this there is a nearly vertical trap dike that places the age of the former as older than the latter. As the country rocks are sedimentary it is not difficult to understand that they would naturally be shattered and fissured by the intrusion of the trap rock, and that the mineral solutions which accompanied the intrusion and continued for some time afterward would circulate through the fissures. It is presumed therefore that these deposits were formed by replacement and are not of magmatic origin as are the magnetite deposits of New Jer-

* Vol. V Trans. A. I. M. E., page 142.

sey and New York. This hypothesis is based on the fact that there is an almost horizontal bedding of the ore which indicates that stratification antedates the formation of the ore, in fact limestone is found alternating with thin streaks of ore that give the whole a banded and often a serpentinized appearance. On Grassy Hill there is a limestone outcrop that is covered with decomposed buff-colored clay that resembles the clay covering of limonite deposits. Traditional reports state that considerable red hematite was mined from one part of this hill, while to the north and west, adjacent to the trap wall, the greenish black magnetic ore was mined.

According to E. V. D'Invilliers, who, after a careful study and examination of the deposits wrote a monograph for the Second Geological Survey of Pennsylvania, "the original formation was made up probably of lime shales containing magnesia, silica, alumina, and iron pyrites. This probability is increased by the bedded and laminated stratification, and it is converted into a certainty by the fact that a considerable thickness of unchanged lime shale layers, passing upwards into solid beds of hard limestone, show themselves near the southern side of Middle Hill mine in the body of the ore mass. These unchanged lime shales at one place are seen resting upon the ore; at another place the limestone beds dip under the ore layers at the same angle and apparently change gradually into ore."

Conditions so far as exploitation goes have changed somewhat since Mr. D'Invilliers' inspection of Middle Hill. Serpentine and other magnesian silicates are found near the junction of the limestone and particularly near the dike, which points rather conclusively to the alteration coming from solutions that were capable of metamorphosing the limestone.

It is possible that the Cornwall deposits, since they are not magnetite magmas like those of New Jersey and New York, may have been formed in one of two ways by the ascending thermal solutions: First, the deposits may have been hematite masses that were changed by the solutions into magnetic masses. Second, the deposits may have been limestone, or such as D'Invilliers describes, that were changed by solutions, in either case it is assumed on good grounds that they were formed by ascending solutions.

Dana, in his System of Mineralogy, stated that: "Deville formed crystals of magnetite artifically by the action of hydrochloric acid on heated ferric oxide; and also by the decomposition of ferric oxide with boracic acid."

Prof. Thomas A. Eggleston, in Vol. V, page 131, of the Transactions of the American Institute of Mining Engineers, says that "some of the hematite ores of Lake Superior

FIG. 1—CORNWALL ORE MINES
No. 1 Steam Hoist to right; Robesonia Hoist in center near tracks; No. 2 Hoist and substation on hill; Ore bin and Stockpile in middle.

contain boracic acid," and he gave the following instructions for its identification:

"Pulverize, calcine and moisten the pulp with sulphuric acid. Heat some of the mass on a platinum wire to expel the sulphuric acid, then moisten with glycerine, and flame. If boracic acid is present it will infallibly give a green flame." This ore gives a green flame, but it may be due to copper, which also gives a green flame.

The structure of the Middle Hill ore is mostly massive, with small pit marks here and there containing small crystals of magnetite, and through the ground mass, pyrite chalcopyrite. and other minerals are found. D'Invilliers mentions 25 different kinds of minerals as being found at these mines, the copper minerals being a cuprous variety of pyrite, chalcopyrite, covelite, cuprite, hydrocuprite, chrysocalla, malachite, and azurite. No analysis of the ore is free from copper. At one time copper was mined as a commercial proposition, approximately $175,000 worth being sold. This was mostly green and blue carbonates and chalcopyrite.

The gangue of the ore is sand, which in places seems to be laminated. The sand is fine and light colored, showing it has been leached, and frequently it appears in small thin folds and contortions like the various layers of hornblende, mica, and quartz in gneiss.

This indicates that acid solutions displaced the limestone, and the sand particles, being insoluble, segregated as found.

Mining operations are said to have commenced at Cornwall in 1740, which is 16 years earlier than at the Forest of Deans mine near Fort Montgomery, in New York state. Tradition states that artillery was made for the Continental army at the old Cornwall furnace.

From the three deposits in Big Hill, Middle Hill, and Grassy Hill over 20,000,000 tons of ore have been removed. The greatest quantity mined in one year was approximately 835,000 tons; however, with the present facilities this no doubt could be increased to 1,000,000 tons, if there was such a demand for the ore. The Lackawanna Steel Company and the Pennsylvania Steel Company are the principal consumers, the market for the ore being narrowed by its low tenor in metallic iron and its high sulphur. The ore, when exposed to the weather, is oxidized to some extent, and loses some sulphur. However, before being charged in a blast furnace it is roasted. An analysis of the ore in percentages is as follows: Silica, 15; alumina, 4; lime, 3.5; magnesia, 5.5; metallic iron, 48; sulphur, 3.5. After it is roasted in Gjers kilns the sulphur is reduced to about 1.07 per cent, and in this condition it is possible to smelt Bessemer pig owing to the extremely low phosphorus content.

Ore is roasted in Colby furnaces very successfullly with blast furnace gas by the Pennsylvania Steel Company.

In Fig. 2 is shown the open-cut workings in Middle Hill, taken from Big Hill in the foreground, which is practically

FIG. 2—Open Cut Workings in Middle Hill.

worked out. Between Big Hill and Middle Hill the railroad tracks are supported on ore left there for that purpose. This view, although taken in 1908, does not materially differ from the conditions governing the mines today, although there have been a number of important surface improvements. Grassy Hill mine is to the rear and right of Middle Hill mine and does not show in the illustration.

The Middle Hill mine has been worked to a depth of 150 feet for approximately a half of a mile; however, there is a considerably greater area to be stripped and exploited besides 150 feet more depth before the bottom of the deposit is reached. In the process of mining, a comparatively light cover of soil and rock is removed, as shown in Fig. 3 on the top bench above the stream shovel. The removal is accomplished by putting down a series of drill holes, then chambering or

FIG. 3—Steam Shovel Loading Iron Ore.

bulling them, and finally loading and firing them with a battery. The cover is thus broken in sizes that the steam shovel can readily load into dump cars. When the cover has been removed a wide bench of ore remains that can be broken so that it falls to the bench on which the steam shovel is working, shown in Fig. 3. In this way there has been formed a series of four stopes or benches from which ore is mined. Fig 4 shows a steam shovel on the floor of the third stope on the foot-wall side of the mine. The locomotive zigzags with the loaded cars from the lower to the upper stopes, although on the present main level the ore is delivered in 50-ton cars to the incline of the crushing and screening plant. The ore car shown attached to the locomotive in Fig. 4 is a 50- ton car which dumps into a steel-foot frame pocket. To break down the ore it has been customary to put down a series of 18 to 24-foot drill holes with air drills on each bench, then charge and shoot the holes simultaneously. In this way a quantity of broken ore can be kept ahead of the steam shovels. Recently two small traction well-drilling machines have been installed to put down holes where depth greater than the air drills can furnish is desired. These are worked on benches

FIG. 4—Steam Shovel and Ore Car on Third Stope.

ahead of the steam shovels, and although slower than air drills, their holes, being larger and deeper, probably even up to the quantity of material broken over a given time. The ore broken from the stopes falls in all sizes, making it necessary to block hole extra large pieces and "block blister," smaller and more suitably shaped pieces. To "block blister," a piece of dynamite has a cap and fuse attached in the usual way, after which it is placed on the ore to be broken and covered with loose dirt. The dynamite, when exploded, breaks up the material into pieces that can be scooped up by the steam shovels, although that machine delivers pieces weighing 3 or 4 tons at times into the cars.

The extreme eastern hoist at the foot of Big Hill is known as hoist No. 1 of the Cornwall Ore Banks Company. This is operated by steam but is at present closed down. Ore from the Big Hill basin is taken through tunnels to the Cornwall Ore Banks Company's No. 2 hoist operated by electricity.

While a large tonnage of ore could be removed from the west end of the Middle Hill mine by cars attached to locomotives, at the present time all ore is hoisted at the eastern end of the Middle Hill mine up two inclines. At this end of the mine it is necessary to sink in order to form a stope that can be carried the length of the mine, and this stope, which is

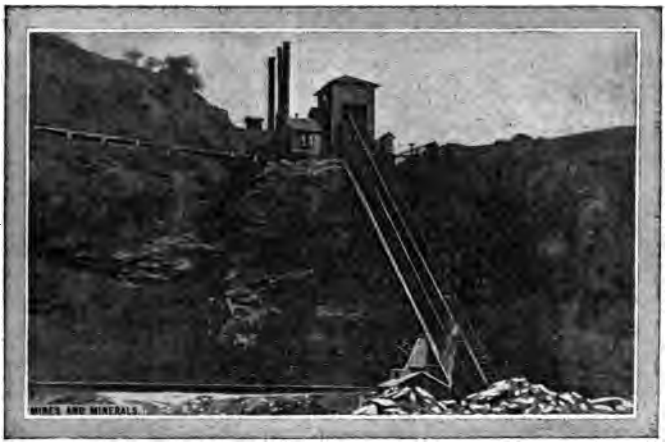


FIG. 5—Eastern Incline Middle Hill Mine.

from 40 to 60 feet high is worked at right angles to the length, that is, the width, for about 400 feet.

The eastern incline in Middle Hill mine, shown in Fig. 5, is operated by the Robesonia Iron Company, who have the right to mine sufficient ore for one furnace only. This company loads ore directly into skip cars which are hauled by mules over several tracks on the main level to the steam hoist where they are hooked to the cable and hoisted from the pit.

At the top the ore is dumped directly into chutes that load the broad-gauge cars. This arrangement necessitates loading cars by hand and sledging up pieces of ore so the men can handle them. However, when in this condition the product is about ready for the furnace. Attention is called to the trap dike to the left of the incline, and to the small quantity of rock in this deep pit.

To the west of the Robesonia incline is a second, or No. 2, incline, shown in Fig. 6, which was constructed in 1909. This is a most interesting installation, consisting of a steel foot house or frame, combined with crusher and skip-loading bin, and a steel head-frame combined with crushing, screening, and transfer arrangements. The foot-frame is 20 ft. x 30 ft. x 70¾ ft., and is covered, as shown in the illustration. The large

FIG. 6—No. 2, Incline and Skip-Loading Bin.

50-ton ore cars when loaded are run into the shed above the frame and dumped into a large hopper which, in Fig. 7, is termed an 85-ton grizzly. Whatever is small enough to pass through the grizzly bars falls into the 100-ton pocket from which the skip is loaded; but whatever passes over them is fed by a 9-foot rotary drum to a 60"x42" Farrel jaw rock crusher. This machine will receive a piece of ore weighing 4 or 5 tons and crush it to 12-inch sizes. To work this crusher it requires 150-horsepower, 25-cycle, three-phase Westinghouse induction motor, making 860 revolutions per minute at 440 volts and 210 amperes. The feed-drum to the crusher sometimes becomes clogged by ore jamming, in which case if the pieces are large and cannot be started by bars, they are blasted. Occasionally a large piece of ore will fall over the mouth of the crusher in such a way as to lodge. To turn this so as to insert it in the jaws a compressed-air hoisting crane,

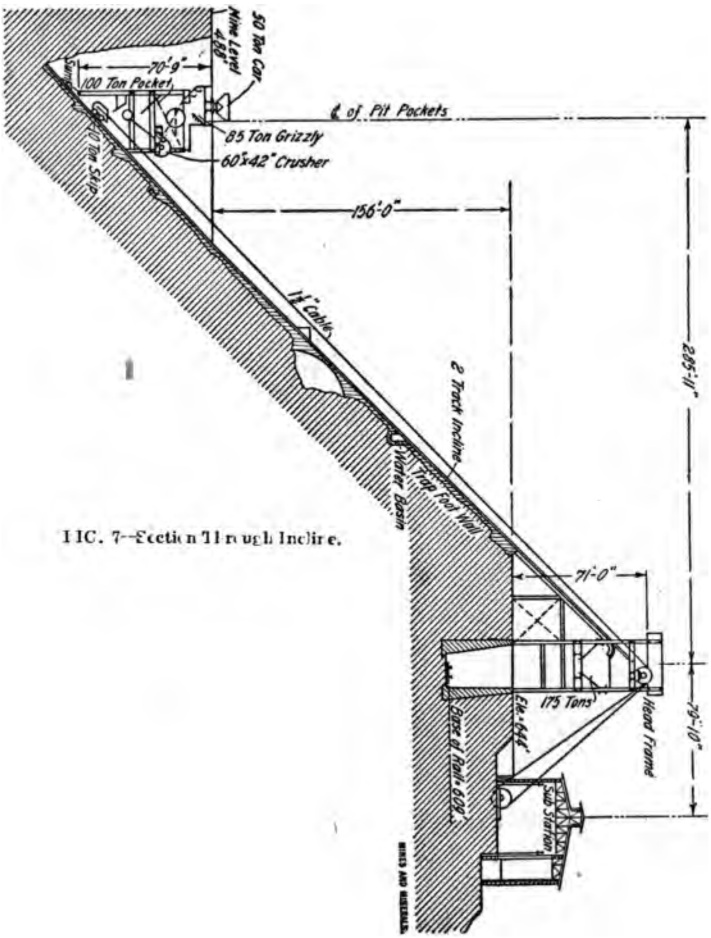


FIG. 7—Section Through Incline.

installed for this purpose, is brought into use. The ore from the crusher falls to the 100-ton ore bin, where it joins the material that passed the grizzly. The ore from this bin is loaded into 10-ton iron skips by means of 6-foot diameter roller feed.

Along the foot-wall above the pit there is a water basin or ditch excavated, which catches the water from the foot-wall and leads it to a brook so that it does not enter the pit. It is only in times of thaws or heavy rains that water is plentiful in the slope sumps, and this is cared for by steam and electric pumps. The hoisting engineer is down in the foot-frame where he can see to the loading of the skip, in fact he controls the motors that rotate the drums. However, he has an assist-

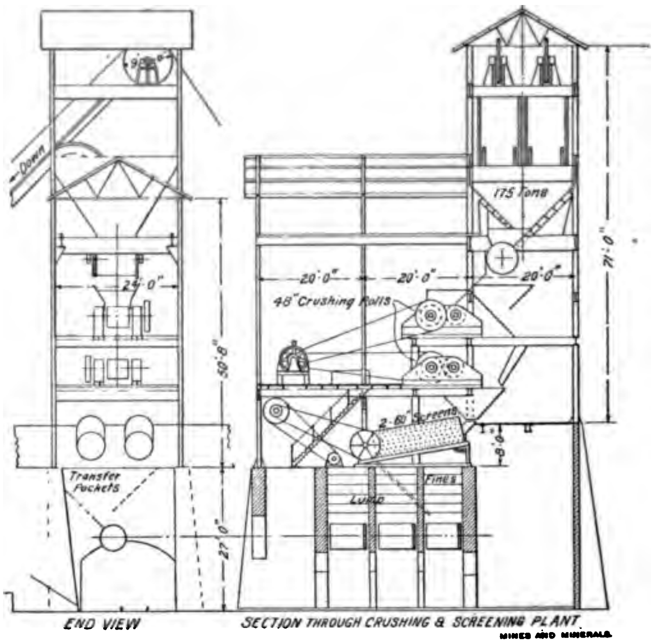


FIG. 8—End View and Section Ore Preparing Plant.

ant who opens and closes the chute gates to the skips. The hoisting is done on two trracks by 10-ton skips attached to 1½-inch steel ropes that are wound on drums driven by electric motors. To hoist, the engineer moves a master switch to the right or left, and as the skip nears the dump at the head-frame, the power is automatically gradually shut off. As the dump is reached, the power is entirely turned off and the air brake goes on. At this point the skip is discharged and held by the compressed air until the engineer releases it by reversing the lever. An end view of the crushing and screening plant attached to the head-frame is shown in Fig. 8. In this plant, motor-driven rolls crush and screen and size the ore previous to its being transferred by a 50-ton electric dump car to the 2,500-ton loading pockets, or 35,000-ton capacity stock-pile trestle. At the pockets the 5-foot roller feed-gates can load a 45-ton car in 4 minutes, including spotting and delivering to the railroad company's tracks. The ore from the stock pile is loaded by steam shovel into railroad cars in case there should be a temporary cessation of hoisting for any purpose. The head-frame, loading pockets, and stock trestle are connected by a steel viaduct which passes over the several railroad tracks, as shown in Fig. 1. The electric power for the various machines is generated at Lebanon, about 6 miles away from the Cornwall ore bank. At Lebanon a furnace belonging to the Pennsylvania Steel Company has a Semet-Solvay by-product coke-oven installation that supplies sufficient gas to run two twin Westinghouse gas engines, each of 1,200 horsepower for the electric power needed at the mines. These gas engines run 3,750-kilowatt Westinghouse dynamos that generate current at 440 volts, which is stepped up to 11,000 volts for transmission to Cornwall. To the rear of No. 2 head-house is the substation where the current is stepped down to 440 volts for use in the various motors. To take care of the heavy peak load in the skip hoist, a rotary converter is provided to give direct current for the 500-horsepower hoisting motor. An electrically operated Ingersoll-Rand air compressor, furnishing 3,200 cubic feet of free air per minute, supplies 13 compressed-air drills and other labor-saving machines at the mine.

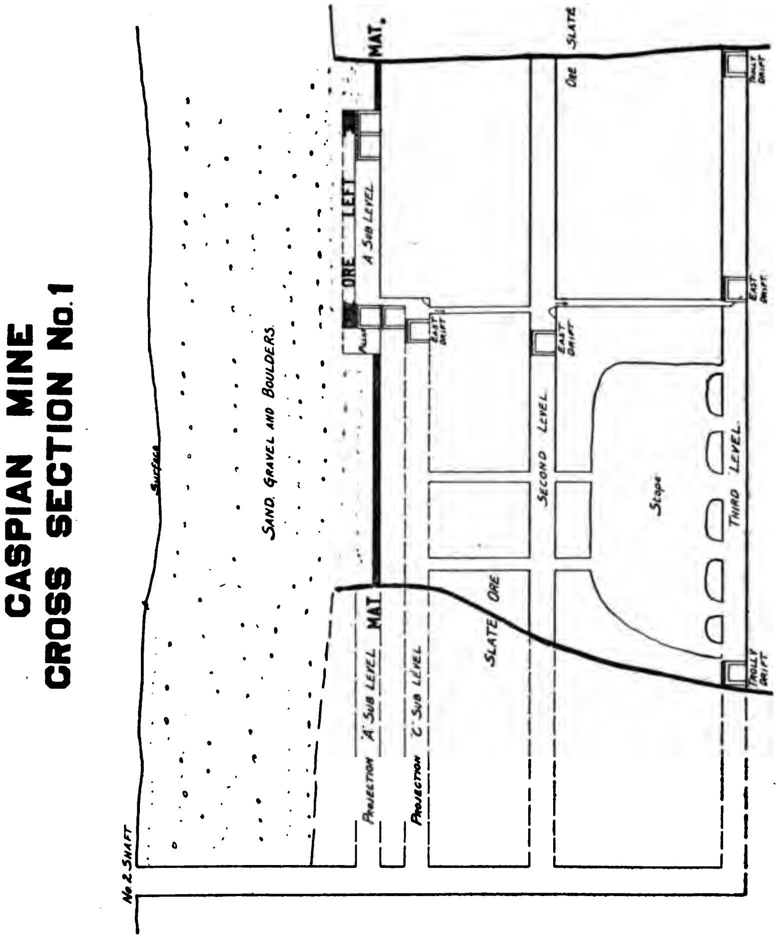
TOP SLICING AT THE CASPIAN MINE.

BY WM. A. MCEACHERN, IRON RIVER, MICH.

The Caspian ore body was found in 1900 by churn and diamond drilling. The surface averaged 130 feet and many of the holes were only chopped into the ledge to determine the best location for a shaft. In January 1902, No. 1 shaft was started. This was a drop shaft and was landed April, 1902, with difficulty, on account of sand and water. The shaft was continued to 380 feet. From the shaft crosscuts were started on the second and third levels and continued across the ore body. Drifts east and west and then crosscuts, 50 feet apart, parallel to the main crosscut, were continued to the rock. No. 2 was also a drop shaft and was sunk to the third level. This shaft is used for lowering men and timber.

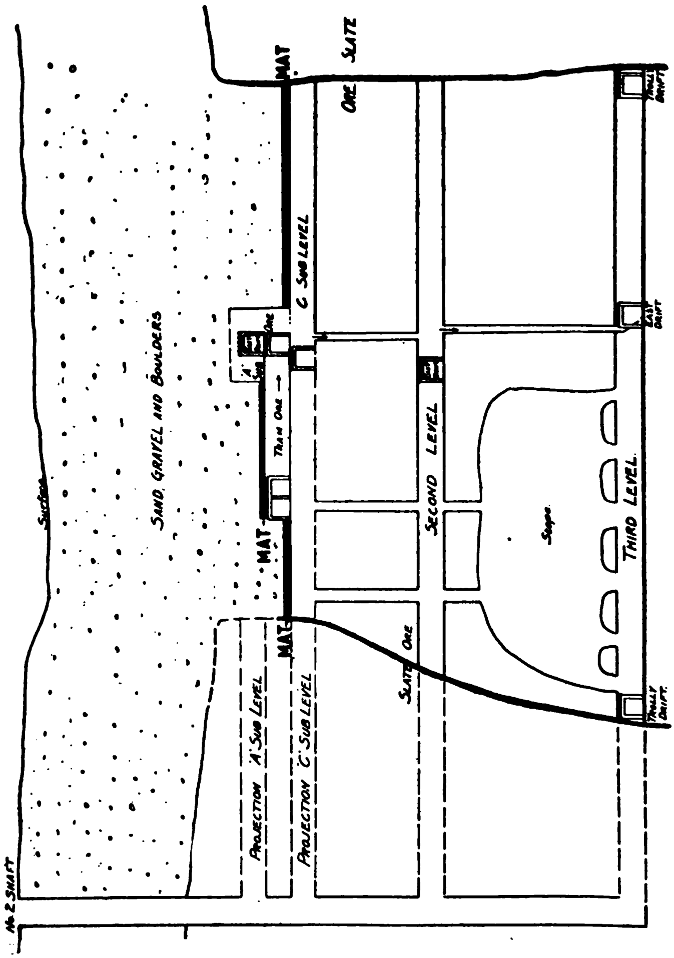
STOPING—Between the second and third levels, nine stopes were opened up. These were started directly over and about ten feet above the back of the crosscut. The method used was back stoping; drilling holes into the back and blasting, then standing on the broken ore and drilling another round of holes. The average size of the stopes was one hundred feet long, twenty-five feet wide and fifty feet high, leaving a pillar of twenty-five feet between the stopes.

DRAINING THE SAND—The ore near the ledge could not be mined until the water was drained from the sand. Very little work was done on the first level, now called "C" sub-level, until 1908. This level was then extended and crosscuts started directly over the crosscuts on the second level. Small raises were put up from this level in various parts of the mine. A twelve-foot test hole was drilled ahead of each cut to ascertain the height of the sand, then six-foot holes were drilled and blasted. When the test hole reached the sand, six-foot holes were again drilled and blasted, leaving five to six feet of ore to hold up the sand. Three more holes were drilled to hasten the drainage. Forty-eight raises were put in and some ran with little decrease in water for over a year.



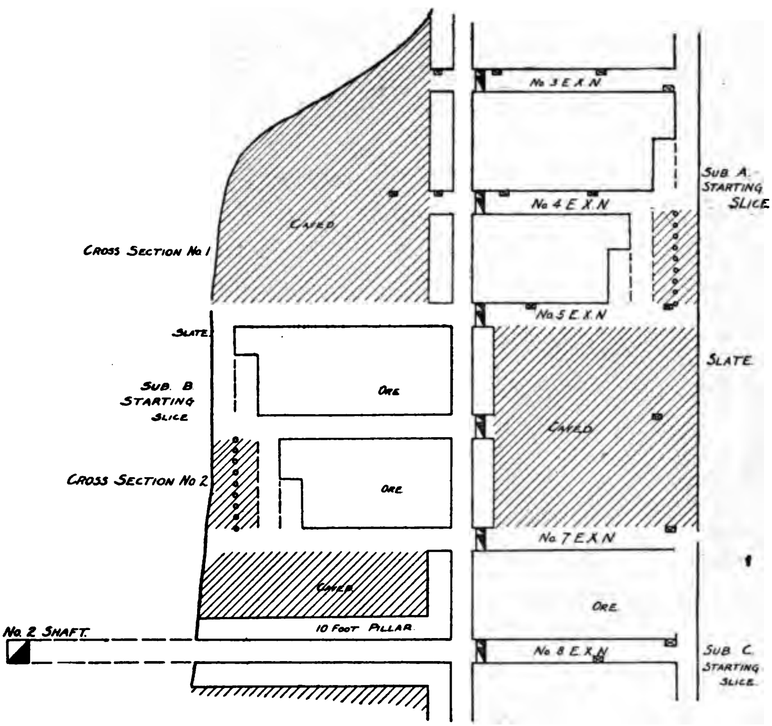
Top Slicing—Top slicing at the Caspian mine is the method by which the ore is mined off at the top in slices ten feet thick and directly under the overburden. In June 1908, a raise twenty feet high was started from No. 5 east crosscut on the first level. This was a cribbed raise and had two compartments, one for ladders and one for ore. The height was determined by the distance to the ledge. When this raise was completed other raises were started and crosscuts east and west were started from them and continued to the rock. This

CASPIAN MINE
CROSS SECTION No. 2



was the beginning of the top or "A" sub-level. The crosscuts were timbered using eight-foot caps and legs and lagging in the back. Connecting the crosscuts on the end completes one slice as shown on the plan. The machine was moved back and another slice eight feet wide was started. These were timbered the same as the crosscuts and lagging laid on the floor when the slice was finished. When the fourth slice was finished the middle legs of the first two sets (shown on plan as small circles) were drilled and blasted bringing the overburden to the floor. The mat which prevents the sand from mixing

CASPIAN MINE.
PLAN OF SUBLEVELS.



with the ore consists here of five feet of ore left behind, and the caps and legs of timber sets and lagging from the back and the floor. The slicing of the pillars was continued until only a ten-foot pillar was left at the main drift. (Cross section No. 1). This operation was carried on in as many crosscuts as the demand for ore required and pillars were left on each side of the main drift for the transportation of timber to the two succeeding sub-levels.

"B" SUB-LEVEL—The back of this level was even with the mat and is ten feet below "A" sub-level. On "B" sub-level there were three points where the operation differed from "A" sub-level:

(a) No back holes were drilled as the ore stripped off the mat.

(b) The timber was kept closely to the breast to hold up the mat.

(c) Boards were used on the floor instead of lagging.

No. 2 cross section shows "B" sub-level on the west side half drawn back, and on the east side finished with the exception of a ten-foot pillar to support the drip. On the east side is also shown a crosscut in "C" sub-level ready for slicing. In any part of the mine slicing or cross-cutting is not begun until the ore is taken out above it.

SUB-LEVELS BETWEEN THE STOPES—Within the next ten years, if one sub-level a year is finished, the sub-levels will be down to the stopes. The stopes must be filled with ore and trimmed and then crosscuts run between the stopes to the rock. The pillars will be sliced the same as before.

When the overburden is let down part will rest on the floor of the pillar and part on the filling in the stope. It will be necessary to carefully watch the chutes to the stope as lowering the filling might ruin the mat and allow sand to mix with the ore.

ELECTRICAL OPERATION OF THE PLANTS OF THE PENN IRON MINING COMPANY.

BY FRANK H. ARMSTRONG, VULCAN, MICH.

All of the machinery of the Penn Iron Mining company, with the exception of two hoists, has been operated by electrical power since the month of March in the year 1908. The hydro-electric plant, from which the power is obtained, was described and illustrated in a paper which was read at the 13th annual meeting of the Lake Superior Mining Institute in the month of June, 1908. A general description of the methods of applying the electric power to the mining machinery was also given in that paper.

Plate I shows the power obtained from the Menominee river for a period of nearly four years. In the year 1910 a 1500 K. W., 3600 R. P. M. Westinghouse-Parsons steam turbine was installed to supplement the hydro-electric plant and for use in case of a break-down at the power plant, or on the transmission line. Since the installation of the turbine, the curves show both the power output from the hydro-electric plant and the mine requirements. The cross hatched area between the two curves represents the amount of power supplied by the steam turbine.

The largest part of the power used for mining is consumed by three classes of machinery, viz: pumping, air-compressing and hoisting.

PUMPING.

For three and a half years there has been in operation at the East Vulcan mine one, and at the West Vulcan mine two Worthington 8-inch, 8-stage turbine pumps, pumping against a head of a little over 1,200 feet. (For description and illustration, see paper referred to above).

The principle improvement made on the pumps since they were installed is in the method of controlling the thrust. The water-step bearing that was put on the discharge end of the pumps soon after starting was at first supplied with water from the discharge pipe at 550 pounds pressure. This is now supplied by a small triplex power pump giving a constant volume of water through the step and positively preventing the revolving and stationary parts of the step from coming in contact. After priming, and opening a 4-inch by-pass valve, the pump is started and then the by-pass valve is gradually closed until the pump is discharging against the full head. The pressure on the step gradually increases from 25 pounds to nearly 400 pounds per square inch, and then decreases as the by-pass valve is still further closed, to approximately 25 pounds.

At the East Vulcan mine a Prescott 8-inch, 8-stage pump was recently installed, having an oil pump driven by the main pump that keeps a constant quantity of oil flowing through the thrust. This oil is circulated continually and relieves the pump of all thrust troubles.

The efficiency of these pumps varies with their condition from 63 per cent to 56 per cent wire at the motor to water at surface. Their capacity can be readily varied from 1300 G. P. M. to 500 G. P. M. by throttling the suction.

At the bottom of the mines, pumping to these station pumps, there are turbine pumps of similar design, with two or three stages according to the lift. As the shaft is sunk deeper, and the pumps are put lower down, the number of stages may be increased by combining the pumps in series. One pump is designed to permit increasing the diameter of the impellers to accommodate the higher head.

The delays due to wear, breakage or accidents, on the one pump at the East Vulcan mine, which had no spare electric pump and was always kept running, except when idle for repairs, amounted to 346 hours in thirty-three months. In other words, the pump was idle due to wear, breakage or accidents about 1½ per cent of the time. The replacing of the steel bushings that prevent the packing from wearing the shaft is the principal repair required.

For smaller quantities motor driven reciprocating pumps are used. There are two for 175 gallons per minute 200 feet head and one for 125 gallons per minute 810 feet head.

COMPRESSORS.

There are in use four motor-driven compressors in the Penn group of mines, as follows:

2 Ingersoll-Rand Compressors.........3100 cu. ft. capacity
1 Laidlaw-Dunn-Gordon Compressor..2200 cu. ft. capacity
1 Ingersoll-Sergeant Compressor...... 950 cu. ft. capacity
(All compress to 80 pounds gage pressure).

The three larger machines are rope-driven, using the Dodge-American system. The smaller machine is driven by a belt. The rope drives are very satisfactory, being quiet, efficient and durable. On the two largest machines owing to lack of space the distance between pulley centers was so short that it was necessary to use a deflector pulley. This puts a reverse bend in the rope and reduces the life somewhat. On the 2200 cu. ft. compressor the first rope (1¼") lasted three and a quarter years. With this machine no deflector pulley is used. The motor pulley is 50 inches in diameter and the compressor wheel is 12 feet in diameter.

Several tests on the Ingersoll-Rand compressors show the efficiency from motor terminals to indicated horsepower of air-cylinders to be 85 per cent.

HOISTS.

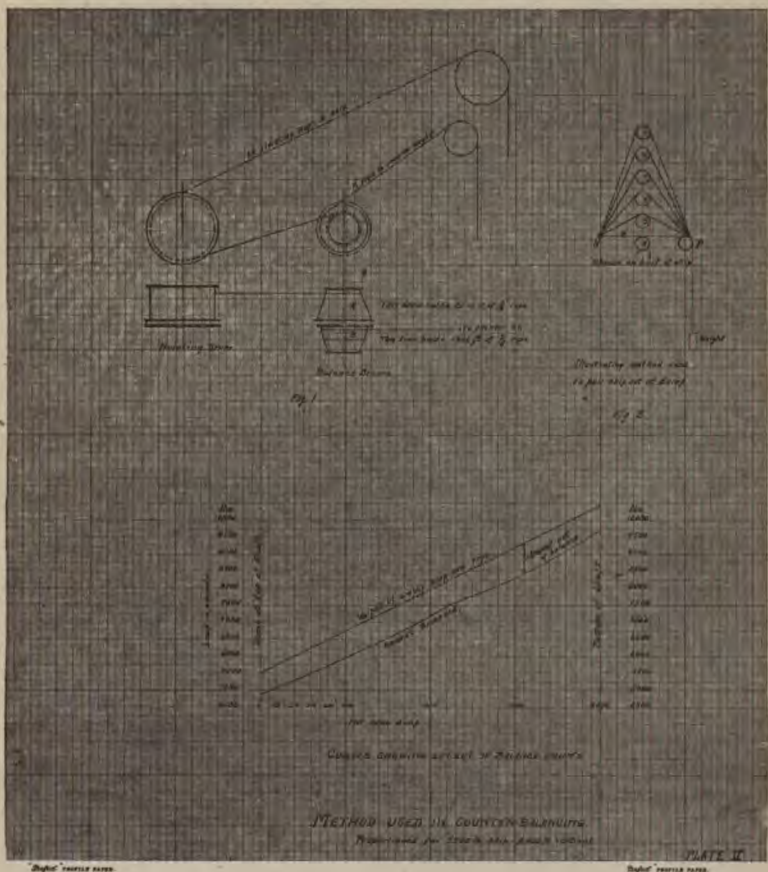
Only the second motion or geared hoists were converted from steam power to electric power. A single skip is sufficient to hoist all the ore at any of the company's shafts. The method of making the change, with illustrations of some of the hoists, is given in the paper referred to above. All of the electric hoists, with the exception of one, have two drums arranged in tandem, keyed to their shafts and driven by Lane band clutches from each of two spur gears running loose on the drum shafts. These two gears are driven by a pinion, on which shaft is also a 22-foot rope-wheel. This wheel is driven from a standard 2200 volt induction motor by a manila rope-drive. The method of starting is to bring the rope-wheel up to speed (which takes from twenty to forty seconds), and then start the drum and load by slowly throwing in the clutch.

The question has been asked as to whether this method of starting is hard on the clutch. Practically the same method has been used for years with all geared hoists. The practice has always been to bring the engine nearly up to speed before throwing in the clutch. The clutch on the new hoist, at the Brier Hill mine, which has been in active operation for nearly two years has never been renewed and shows almost no wear. The clutches on the converted steam hoists last fully as long as they did when they were operated by steam.

In order to approximate closely the efficiency of first motion plants it is necessary to counter-balance the dead weights of skip or cage and rope. The method used for this purpose is illustrated in Plate II of this paper. The two balance-drums are keyed to the same shaft, and of course, revolve together. Drum "A" is the larger of the two and is connected by a ⅞ inch rope to the main hoisting drum. From the other drum ("B") a ⅞ inch rope leads to the counter-weights hanging in the shaft. Drum "B" is smaller than drum "A," thus giving the counter-weight a shorter travel than the skip, so that it is never above the collar of the shaft, at which point it might freeze while the skip is at the bottom waiting for a load. The tapers on these drums are designed so as to give as nearly a perfect balance as possible, at all points in the shaft. The curves at the bottom of Plate II show this. It is, of course, necessary to be out of balance enough to pull the drums around in lowering.

Without some further device a Kimberly skip as perfectly balanced as shown by the curve would not come out of the dump, where a large part of the weight of the skip is sup-

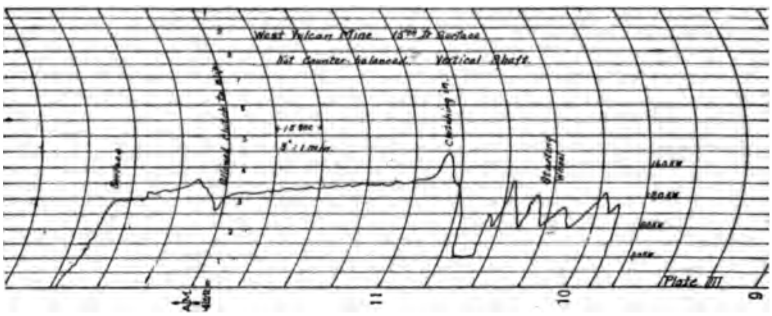
ported. To pull the skip out of the dump, and allow more perfect balancing, a device is used in the shaft-house, the principle of which is illustrated in Figure 2 of Plate II. Across the skip road is a rope ("R"), one end of which is anchored at "N." This rope then goes over pulley ("P") and supports a weight as shown. On the bail of the skip is a 30-

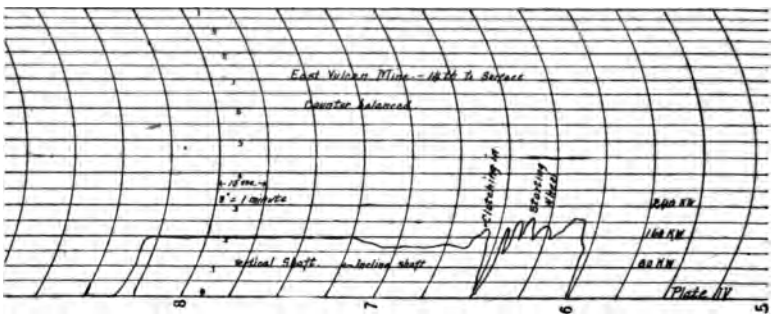


inch sheave ("S") which strikes the rope ("R") when the skip is coming up, just as the skip begins to tip. As more of the weight of the skip is carried by the dump, more downward pull is exerted by the weight through rope ("R").

Anchor ("N") and pulley ("P") are stationary while sheave ("S") on skip bail rises to various positions as shown.

The results of this method of hoisting are shown by the curves on Plate III, IV and V.





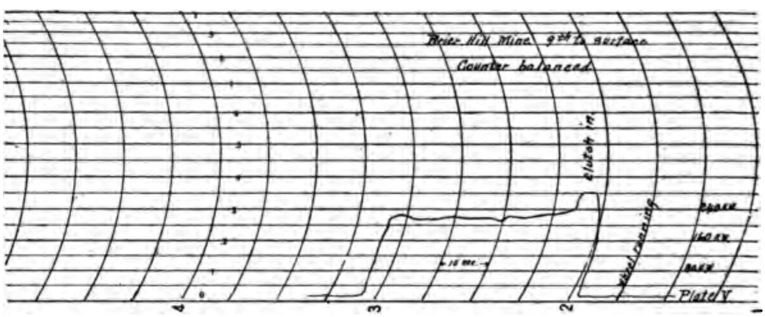


Plate III is the load curve for hoisting a cage of men vertically, taken with a curve-drawing wattmeter. This cage is not balanced and the effect of the weight of the rope is plainly seen.

Plate IV is the load curve for hoisting ore in a shaft, the lower part of which is at an incline of 60 degrees from the horizontal. The increase in power required from the turn up in the shaft is shown. This skip is balanced and the wattmeter curve shows almost perfect balancing.

Accurate information as to the number of K. W. hours used for hoisting under various conditions is valuable. Below are two tables showing the average K. W. hours used per day, per ton, and per ton-foot at the Brier Hill mine. The skip holds 6 tons of ore. Both skip and cage are counterbalanced. Before making these tests, a switch was put in the meter circuit that enabled the brakemen to cut out the meter when the cage was being hoisted. The first table and results are for hoisting ore only. The second table includes the operation of the cage, handling men, timber, tools, etc.

The following table gives the distance the skip travels from level to dump in a vertical shaft, the average number of tons of ore hoisted per day from each level (the records covered one week of 5½ days), and the K. W. hours used for the 5½ days, as recorded by a calibrated polyphase integrating wattmeter.

TABLE I.

Level	Distance	Tons	Ton Feet	Meter Reading	K. W. Hours
5th	480 ft.	4.8	2304	7 A. M. Monday......	5947040
6th	592 ft.	30.0	17760	6 P. M. Saturday......	5950236
8th	780 ft.	178.8	139464	Difference...............	3196
9th	887 ft.	255.6	226717	Divide by 5½ days, Aver of	.581
Tot., Av. day		469.2	386245	K. W. Hours per day.	

The above table gives 1.238 K. W. hours per ton of ore from an average vertical depth of 823 feet, or a power consumption of .001504 K. W. hours per ton foot.

TABLE II.

Level	Distance	Tons	Ton Feet	Meter Reading	K. W. Hours
5th	480 ft.	12	5760	7 A. M. Monday......	5955210
6th	592 ft.	8.4	4973	6 P. M. Saturday......	5960040
8th	780 ft.	246.6	192348	Difference...............	4830
9th	887 ft.	261.6	232039	Divide by 5½ days, Aver. of	.878
Tot., Av. day		528.6	435120	K. W. Hours per day.	

The above table gives 1.66 K. W. hours per ton of ore from an average depth of 823 feet, or a power consumption of .002018 K. W. hours per ton foot.

REMINISCENCES OF THE EARLY DAYS ON THE GOGEBIC RANGE.

By John H. Hearding, Duluth, Minn.

IRONWOOD IN 1887.

When I first arrived in Ironwood in April, 1887, the only railway completed into the town was the old Milwaukee, Lake Shore & Western, now a division of that excellent system, the C. & N. W. It was April 20th and very warm in Milwaukee when I left; but, as I dressed at about 6 a. m., I noticed that the small lakes we were passing were still coated heavily with ice, and an occasional patch of snow could be seen in the heavy timber.

I was met by an old Milwaukee friend, John G. Thompson, who was then cashier of the Norrie Mine; and, let me explain here that the purpose of this article is to bring back to the memory of some of the "old timers" the familiar faces and figures that were prominent and well known at that time in this city. The train came up by way of Watersmeet, as the Rhinelander cut-off had not been built. The depot was on the other side of the track from where it now stands, and, as I remember, we walked directly from there to the corner of Suffolk and Ayer streets. Ayer street was commonly known as "Front street" because the town was built up along this street originally; as the railway yards were parallel and opposite, as now, and naturally it was the first to be improved, in order to take care of the unloading of freight—a very important thing in a new town.

On one corner of Suffolk street and Ayer there stood the store of Bingham and Perrin—a combination building of frame and logs. Opposite or on the westerly side was the St.

James Hotel, a building of two stories extending nearly to the alley. In the corner store of the St. James was the Bank of Ironwood, over which presided as cashier, Otto Karste. Going westerly from the St. James Hotel on Ayer street one saw numerous wooden buildings, with a variety show and saloons in them; the largest was the Alhambra Theater, a two-storied variety show of the worst character, run by one Paddy O'Neil, whose boast was that of a head so hard that he could butt the panel out of any bar in town.

Occupying a corner similar to the St. James but a block east was the Walker House, the first hotel in town, I was given to understand. Across from that building was Fred Prescott's hardware store, a group of low single story buildings that have only been removed during recent years. Westerly from Bingham & Perrin's store were the usual two-story frame buildings occupied by different business enterprises, mostly saloons, excepting the further corner one which was occupied by the Ironwood Store company, whose destinies were presided over by Thos. Atkinson.

Up Suffolk street on Bingham & Perrin's side were several frame buildings, one a saloon of an old French-Canadian, a Civil war veteran and quite a character. His family difficulties were generally settled between himself and his wife in public; his wife occupying the middle of the road, which was generally knee deep in mud, and he occupying the front door. Their language on such occasions was hardly repeatable in any society, and one of the preliminaries at the fray was his carrying her sewing machine down to the express office and ordering it sent to Peshtigo, their old home, which was never done by W. L. Pierce, the agent for the company, whose office was next to the Bank of Ironwood on Ayer street. The corner building, where Davis and Fehr's store now stands, was a frame one occupied by Chet Boyer's saloon. Across from there was Harry Weeden's drug store and Will Winslow's jewelry store, where the Bank of Ironwood now stands. Between that building and the St. James were several buildings, one of which was occupied by the postoffice, the postmaster being George Kelly; another, as I remember, was occupied by I. M. Beans' jewelry store.

This was the general view I obtained of the town when I arrived. The frost was just going out of the streets and before getting my breakfast I went to Bingham & Perrin's and purchased a pair of rubber boots, as Mr. Thompson told me they would be absolutely necessary. We then went to breakfast at the St. James and I then met several of the gentlemen I have already mentioned. At this time, I believe, I also met Mr. C. H. Munger, then superintendent of the Odanah Mining company.

The dining room of the St. James was in reality a store. The office another store room with the rear partitioned off to make a kitchen. Naturally there was a door in the front part of the dining room that opened immediately onto the sidewalk The door was supplied with a screen and usually hooked on the inside. Its being unhooked caused considerable embarassment to the speaker one day when a total stranger, with more liquid refreshments inside than was good for him, walked into the dining room and up to the table where I was seated with several others, and to their great amusement gave out the following sentiment: " Say Jimmy, if you're going to be a sport, blow yourself." He was removed by the proprietor, C. J. Laughren, immediately. After breakfast I went up to the Norrie mine and was initiated by Mr. Thompson into the duties of timekeeper. As we walked up Suffolk street I noticed several buildings and will mention them to possibly bring to the minds of others who were there at the time those that I have forgotten.

Where the First National Bank building now stands, there was a vacant lot, on the third lot from the corner was a hardware store run by Ed. Maxon, and next to the alley where it now stands was Mullen Bros.' furniture store. A hotel building was being erected where the new St. James now stands, called the Grand Hotel, from which the new St. James was remodeled. On the corner of Aurora and Suffolk, opposite the present First National was a residence occupied by Matt Fitzsimmons, Sr. I believe one other store building was erected in that block, but I am not absolutely sure. Pierce's Opera House graced its present site with Wm. Rothschilds building opposite facing on Ashland street. A few other buildings were also erected further up the street, among them, George Kerbitz saloon, well known and liberally patronized, but exactly how many I do not remember. On the left hand side of the last block were two boarding houses, and between them and town was J. H. D. Stevens, the then new probate judge's residence.

An amusing incident occurred in his election which had just taken place. His opponent was a painter, who later ran a saloon in Ironwood. The majority for Stevens was about 5, as I remember it, but after the election and within two years, a quiet looking gentleman arrived in town from Chicago and invited Stevens' opponent to return to that place under charge of highway robbery. Had Stevens received three less votes Gogebic County's first probate judge would have had to leave his honorable position for an Illinois penitentiary. I believe his sentence was reduced to one year on account of his life in Ironwood.

A conspicuous land-mark at the head of Suffolk street was No. 3 shaft house, Norrie mine. Between the end of the street and the shaft were large piles of timber and a large log barn; also a double log camp, which was the original exploration camp. In the log camp lived the surface foreman of the Norrie; none other than Jim Redmond, at one time sheriff of Florence County, and then a victim of tuberculosis. His trouble was caused by a bullet wound in his lungs inflicted by the County attorney of that County. He told me the story, which is a familiar one to many of our Menominee Range members. Even the old log barn had an experience, for in later days, it partially slid into a cave with John Bridges, the barn boss, and about 10 horses in it.

The last house on the left of the street, and next to a saloon bearing the familiar sign, "First and Last Chance," was occupied by Captain William Trebilcock of the Norrie mine. The Norrie in the spring of 1887 had three operating shafts, Nos. 3, 4 and 5, No. 4 shaft being the original. They were all working on the second level with the shafts down to the third. No. 6 shaft was being sunk and No. 7 was a small shaft down to one level. At the East Norrie No. 3 shaft was the only opening, there being a small open pit in connection with it on the first and second level. The mining captain of the East Norrie was our present president, D. E. Sutherland. S. S. Curry was president and general manager, J. D. Day was superintendent, William Trebilcock captain of the Norrie and W. H. Knight, well known as "Bill" Knight, was night captain. The Norrie and East Norrie were then operated by the Metropolitan Iron & Land Co.

At the Ashland mine, J. H. Taylor was superintendent and Jas. McKenzie captain. The engineer and chemist of the Ashland was then a young man who lived in a small room adjoining the laboratory, and boarded in Hurley, one of the best liked and brightest men in the community, with a good nature that has lasted him until now. He rose from that position through various others to the head of the largest iron mining corporation in the country, which position he now occupies—Mr. W. J. Olcott, our ex-president. Another of our ex-presidents was then mine inspector of Gogebic County, J. Parke Channing. The superintendent of the Aurora mine was Captain Nat Hebbert and Geo. Brewer was mining captain. Major Baetz was superintendent of the Pabst mine and I think W. W. Stevens was mining captain. My recollection is that Chas. (Chuck) Stevens was then superintendent of the Iron King, now the Newport. Captain Mat Fitzsimmons was sinking an exploration called the North Aurora. The Bonnie, Blue Jacket, First National, Geneva, Puritan, Ironton and Valley mines were then working between Ironwood and Bessemer, and at Bessemer was the first mine to ship from the range, the Colby, whose manager was Jos. Sellwood, and Harry Roberts was mining captain.

West of the Montreal river on the Wisconsin side an exploration was going on called the Minniwawa operated then by the Pence & Snyder Development Co. R. J. Trimble was the manager and R. R. Trezona, superintendent. This same firm was also interested in the Pence and Father Hennepin mines. Then came the Germania on top of the hill back of Hurley, which was under the same management as the Ashland, and whose head was the present insurgent congressman from California, "Red" E. A. Hayes. His brother, J. O., was also in the management. Beyond the Germania came the Nimicon, Kakagon, Bessemer and Odanah mines with many others farther west that then were only explorations. These names and their locations are written from memory and I may not be entirely accurate though in the main I think they are.

During the spring of 1887 there was a great deal of building throughout Ironwood and new buildings could be seen springing up all over the town. Marquette street had just been cut out of the timber and new houses were going up all along it. Vaughn street terminated at its present juncture with Mansfield and the timber covered all of the ground now occupied by the residence portion of the town east of Mansfield street. The timber continued through without hardly a break to the Pabst mine. On the north side of the county road there were no breaks in the trees. The hills back of the Norrie and East Norrie mines were covered with the original forest which continued unbroken to the south. On the north side of the tracks only a few pioneers, such as Jas. Monroe, Robert E. Mace, Al. Hammond and W. H. Knight, Jr., had ventured to build. During the winter of '87-'88 wolves could often be heard howling in the swamp south of the East Norrie and deer were very plentiful close to town.

On September 17th, 1887, a fire originating in a small frame building close to the Alhambra Theater on Ayer street extended rapidly to the surrounding buildings. There was nothing in the town in the way of fire protection and it soon extended easterly along Ayer street, burning south toward the mines as far as the alley between Aurora and Ashland streets, practically clearing out all the business portion of the city. In spite of this disaster the town soon rebuilt, but the business section moved to its present location, and this description of old Ironwood is given to explain to those who did not see it, some of its past glories.

BIOGRAPHICAL NOTICES.

GEORGE P. CUMMINGS.

George P. Cummings, whose death occurred in the city of Marquette, Michigan, March 13, 1911, was born at Morgan, Vermont, Nov. 18, 1826. Early in life he was identified with railroad construction in his state, he being a civil engineer. At one time he held the position of master of transportation on the Concord, Manchester & Lawrence railroad. He was married in Vermont to Hannah Elsen Ropes in 1851. One son, Charles, survives his parents. Mr. Cummings resided in the city of Marquette since 1857. He held the positions of civil engineer, surveyor and land agent, and for many years was the official surveyor for Marquette county. Mr. Cummings took a great interest in the mineral development of the Lake Superior country, was an ideal American citizen and a pioneer whom all who knew him admired.

CAPTAIN THOMAS OLIVER.

At the age of 59 years, 4 months and 18 days, Captain Thomas Oliver passed away at his home in Norway, Michigan, June 5, 1911.

Captain Oliver was a native of Cornwall, England, raised in early youth among the mines of his birthplace, engaging in the mining pursuit at a very early age as was common with boys of his time. While still young he came to America, entering mining work in Marquette county. In 1880 he removed to the Menominee iron range where he was for several years at the Norway mine. Later he took charge of the underground workings of the Curry mine of the Penn Iron Mining Company. Later he went to the Gogebic iron district where he took charge of mining operations at the Newport mine. Ironwood. He remained in this position several years when he returned to Norway, where he built a fine residence and proceeded to enjoy the fruits of his activities, but in which pursuit he was early cut off by an insiduous disease that baffled the skill of the best physicians. His widow, five sons and two daughters survive him. Captain Oliver was a thorough miner and did his full share in the development of the mineral resources of this region.

Donald Archibald Cameron.

Donald Archibald Cameron, whose death occurred at Norway, Dickinson County, Michigan, April 7, 1911, was born in Martintown, Ontario, Province of Canada, August 15, 1861. He was a graduate of Toronto University, adopting law, opened an office at Toronto where he practiced a couple of years, after which he came to the United States, locating at Iron Mountain, Michigan, in 1887, where he continued in the practice of his profession. He was married in 1894 to Miss Eva Monroe, who with two children, Claire and Paul, survive him.

George C. Stone.

Born, at Shrewsbury, Massachusetts, November 11, 1822; died at Duluth, Minnesota, October 25, 1900.

To no one man can more credit be given for the opening of the mines of the state of Minnesota to the industrial world than to George C. Stone. It was largely due to his energy, persistence and faith that the hard ore deposits at Soudan were first brought to the light of the commercial day, developed, and given their true significance to the country at large.

Early in life Mr. Stone had come West. For many years, at different times he was banker and merchant in Iowa and Minnesota. He had made and lost several fortunes. In 1876 he moved to Philadelphia. He was "broke" and engaged in a small manufacturing business, but his mind had bigger things in view and he soon returned to Duluth to investigate outcrops of iron ore about Vermilion Lake, from which place an explorer and government surveyor, Mr. George R. Stuntz, had secured attractive samples which he had shown to Mr. Stone. Having known Mr. Charlemagne Tower, of Philadelphia, as a successful coal mine operator, he sought his aid, and finally, after many trials, secured it after he had the property examined by Professor Albert H. Chester, of Hamilton College, New York, who reported favorably upon it. Mr. Stone then took up his residence at St. Paul, Minnesota, to carry out the plan he and his associates had formulated. After much delay the Minnesota Iron company was the result of the effort, the organization having a capital of ten million, very high for that period. Then followed years of the hardest kind of struggle to keep the enterprise going. A panic interfered. It was a new field, seventy miles from anywhere, prejudices against it were many. For several years supplies were received by sleds in the winter season the swamps being impassable at other times of year. It was a long, hard fight, but it finally won. Mr. Stone cleaned up half a million for his work, while Mr. Tower recovered the three million he had invested with big interest. Elisha Morcum, who was superintendent of the Chapin mine, Menominee range, Michigan, was the mining manager for the Soudan, the initial iron ore mine in Minnesota. He brought with him Amos Shephard and a large crew of Cornish miners. During those years Mr. Tower was president of the Minnesota Iron company while Mr. Stone was its general manager and treasurer. Mr. Stone was also president of the Duluth & Iron Range Railroad company, and later became managing director of the mining company.

H. B. Sturtevant.

H. B. Sturtevant, whose death occurred Nov. 22, 1910, at Philadelphia, was born in Delavan, Wisconsin, in October, 1857. He was educated as a civil engineer, his first services being with the Chicago & Northwestern Railway company, where he was engaged for several years when he became the engineer for the Lake Superior Iron company, Ishpeming, where he filled important positions in his line, resigning to take charge of mining properties at Ely, Minnesota, where he was located until a few years before his death when ill health compelled him to seek another climate. Mr. Sturtevant was a most active man in all work he undertook and had many warm friends throughout the mining regions of the Lake Superior country.

PAST OFFICERS.

PRESIDENTS.

Nelson P. Hulst 1893
J. Parke Channing 1894
John Duncan 1895
William G. Mather 1896
William Kelly 1898
Graham Pope 1900
W. J. Olcott 1901
Walter Fitch 1902
George H. Abeel 1903
O. C. Davidson 1904
James MacNaughton 1905
Thomas F. Cole 1906
Murray M. Duncan 1908
D. E. Sutherland 1909
William J. Richards 1910

(No meetings were held in 1897, 1899 and 1907).

VICE PRESIDENTS.

	1893.	
John T. Jones.		Graham Pope.
F. P. Mills.	J. Parke Channing.	M. W. Burt.
	1894.	
John T. Jones.		Graham Pope.
F. P. Mills.	R. A. Parker.	W. J. Olcott.
	1895.	
F. McM. Stanton.		Per Larsson.
Geo. A. Newett.	R. A. Parker.	W. J. Olcott.
	1896.	
F. McM. Stanton.		Per Larsson.
Geo. A. Newett.	J. F. Armstrong.	Geo. H. Abeel.
	1898.	
E. F. Brown.		Walter Fitch.
James B. Cooper.	Ed. Ball.	Geo. H. Abeel.
	1900.	
O. C. Davidson.		J. H. McLean.
T. F. Cole.	M. M. Duncan.	F. W. Denton.
	1901.	
J. H. McLean.		F. W. Denton.
M. M. Duncan.	Nelson P. Hulst.	William Kelly.

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	1903.	
Graham Pope. Amos Shephard.	Wm. J. Richards.	T. F. Cole. John McDowell.
	1904.	
John McDowell. Wm. J. Richards.	John C. Greenway.	William Kelly. H. B. Sturtevant.
	1905.	
John C. Greenway. Jas. R. Thompson.	William Kelly.	H. B. Sturtevant. Felix A. Vogel.
	1908.	
James R. Thompson. Felix A. Vogel.	John C. Greenway.	J. Ward Amberg. Pentecost Mitchell.
	1909.	
F. E. Keese. W. J. Uren.	L. M. Hardenburg.	Charles E. Lawrence. Wm. J. West.
	1910.	
Frank E. Keese. Charles E. Lawrence.	William J. Uren.	L. M. Hardenburg. William J. West.

TREASURERS.

C. M. Boss 1893
A. C. Lane 1894
Geo. D. Swift 1895-1896
A. J. Yungbluth 1898-1900
Geo. H. Abeel 1901-1902
E. W. Hopkins ....1903-....

SECRETARIES.

F. W. Denton 1893-1896
F. W. Denton and F. W. Sperr 1898
F. W. Sperr 1900
A. J. Yungbluth ....1901-....

LIST OF PUBLICATIONS RECEIVED BY THE INSTITUTE.

American Institute of Mining Engineers, 99 John St., New York City.

Canadian Mining Institute, Ottawa.

American Society of Civil Engineers, 220 W. 57th St., New York City.

Institution of Mining Engineers, Neville Hall, Newcastle-upon-Tyne, England.

Massachusetts Institute of Technology, Boston, Mass.

Chemical, Metallurgical and Mining Society of South Africa, Johannesburg, S. A.

Western Society of Engineers, 1734-41 Monadnock Block, Chicago.

The Mining Society of Nova Scotia, Halifax, N. S.

Canadian Society of Civil Engineers, Montreal.

North of England Institute of Mining and Mechanical Engineers, Newcastle-upon-Tyne, England.

State Bureau of Mines, Colorado, Denver, Colo.

Stahl und Eisen, Dusseldorf, Germany, Jacobistrasse 5.

Reports of the U. S. Geological Survey, Washington, D. C.

Geological Survey of New South Wales, Sydney, N. S. W.

Geological Survey of Ohio State University, Columbus, O.

The Mexican Mining Journal, Mexico City, Mexico.

Mines and Mining, 1824 Curtis St., Denver, Colo.

Engineering-Contracting, 355 Dearborn St., Chicago, Ills.

Mining Science, Denver, Colo.

Mining & Scientific Press, 667 Howard St., San Francisco, Cal.

University of Oregon; Library, Eugene, Oregon.

Case School of Applied Science, Department of Mining & Metallurgy, Cleveland, Ohio.

University of Illinois, Exchange Department, Urbana, Ills.

University of Missouri, Columbia, Mo.

Iowa State College, Ames, Iowa.

Mining and Metallurgical Society of America, 505 Pearl St., New York.

American Mining Congress, 1510 Court Place, Denver, Col.

Oklahoma Geological Survey, Norman, Okla.